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Studies on the flora of northern South America—V*

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Miscellaneous New or Noteworthy Species

The herbarium of the New York Botanical Garden contains thirteen species of *Dioscorea* from British Guiana and about as many more have been reported in literature. Among our thirteen are three undescribed species and one which requires a new name.

Dioscorea lanosa n. sp. Stem herbaceous, twining to the left, sparsely and finely villous near the nodes; petioles channeled above, thinly villous, 25–30 mm. long; leaf-blades elliptic from a cordate base, the largest 95 mm. long and 57 mm. wide, excluding the basal lobes, which are 7–8 mm. long, broadest near the middle, abruptly acuminate into a short point, glabrous above, thinly villous beneath, especially along the primary and secondary veins, 7-nerved, the first, second, and third confluent at the apex, the fourth and fifth arcuately spreading and extending to or beyond the middle of the leaf, the sixth and seventh barely surpassing the basal lobes, bifid or usually trifid near the base; pistillate spikes not seen; staminate spikes single or paired in the axils, unbranched, 10–17 cm. long, the rhachis strongly angled, thinly but conspicuously villous; flowers in clusters of two to five; pedicels 2–4 mm. long, angled, recurved-spreading, densely villous, each subtended by an ovate-triangular long-acuminate bract, which is pubescent on the back and thinly wing-margined; perianth campanulate, about 1.5 mm. long, weakly angled or nearly terete, the lobes united for two fifths of their length, oblong-ovate, acute, densely villous without, glabrous within; stamens 6, inserted at the base of the perianth-tube and about equaling it in length; filaments erect and connivent at base, abruptly spreading near the slightly enlarged apex; style-rudiment apparently none.

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Type, *La Cruz 3875*, collected along the Wanama River, Northwest District, lat. 7° 45′ N., long. 60° 15′ W., and deposited in the herbarium of the New York Botanical Garden.

Dioscorea lanosa is closely related to *D. pilosiuscula* Bertero, and is distinguished from it by the prominent basal sinus of the leaf, the fourth and fifth veins arcuately spreading, the acute lobes of the perianth, and the villous rhachis.

Dioscorea oblonga n. sp. Stem herbaceous, angled, glabrous, twining to the right; petioles about 5 cm. long, minutely verrucose; leaf-blades broadly cordate-triangular with a deep basal sinus, the largest 10 cm. wide, sharply acuminate, glabrous, the basal lobes broadly rounded with a broad obtuse sinus, first, second, and third veins extending to the apex, fourth and fifth arcuately spreading and reaching past the middle of the leaf, sixth and seventh conspicuously bifid and not extending beyond the basal lobes; staminate spikes in a loose panicle, paired or occasionally single, slender, unbranched, 9–12 cm. long; bracteal leaves ovate-lanceolate, truncate at base, long-acuminate, 10–25 mm. long, 2–12 mm. wide, on petioles 2–10 mm. long; rhachis strongly angled or narrowly winged, glabrous or minutely scabrellate on the angles; flowers sessile in small capitula subtended and about equaled by ovate-lanceolate acuminate bracts; perianth subglobose, about 1.5 mm. long, deeply 6-lobed, glabrous, the lobes round-ovate, obtuse, 1-nerved, very thin; stamens 3, the stout filaments about as long as the perianth-tube, divergently branched above, marked with red at the apex, each branch bearing an anther-sac; staminodia 3, slender, Y-shaped, about equaling the filaments; pistillate spikes solitary, axillary, 8 cm. long, narrowly winged, glabrous; bracts linear-subulate, 2.5 mm. long; ovary narrowly fusiform, 4 mm. long, with 3 narrow wings and 3 thick lobes, minutely red-dotted; corolla subglobose, 1 mm. long; styles 3, short, connivent, with divergent stigmas; fruiting spikes becoming 3 dm. long; fruit reflexed, as much as 28 mm. long, the wings semi-obovate-oblong, 9 mm. wide, broadly triangular at apex.

Type, *Hitchcock 17559*, collected at Issorora, Aruka River, lat. 8° 10′ N., long. 59° 50′ W., and deposited in the herbarium of the New York Botanical Garden.

D. oblonga is most closely related to *D. polygonoides* H. & B., from which it is well differentiated by the much longer and more pointed fruit.

Dioscorea trichanthera n. sp. Stem about 2 m. long, angulate, glabrous, or minutely puberulent, twining to the right; petioles slender, 45–60 mm. long, mostly glabrous or more or less puberulent near the base and the dorsiventrally flattened apex; leaf-

blades broadly ovate-triangular to ovate-oblong, 55–100 mm. long, 33–58 mm. wide, exclusive of the basal sinus 10–22 mm. deep, thin and membranous, glabrous above, slightly paler beneath and sparsely hirsute with curved, nearly appressed hairs 0.3 mm. long, or varying to nearly glabrous, abruptly narrowed at the apex into a narrowly triangular acumen 4–10 mm. long, sparsely glandular near the base, pellucid-lineate, the basal sinus rounded, the basal lobes broadly rotund; second and third veins arcuately ascending and entering the apex, fourth and fifth divergently spreading and extending one third to one half the length of the blade, sixth and seventh not passing beyond the basal lobes, simple, or in the largest leaves inconspicuously bifid, nearly parallel to the margin; pistillate inflorescence not seen; staminate racemes single in the axils of the upper leaves, unbranched, 10–20 cm. long, the rhachis angled, thinly to rather densely short-villous or subhirsute, floriferous from near the base; pedicels single or paired, 1–2 mm. long, hirsute; bracts 2, ovate, acuminate, glabrous, the lower somewhat the larger and equaling or exceeding the pedicel; perianth-tube very short; perianth-lobes widely spreading, 3 mm. long, 1 mm. wide, rather thick, oblong, acute or obtusish, glabrous within, glabrous or sparsely pilose with a few short hairs without; stamens 6; filaments 2 mm. long, terete below, laterally flattened at the apex, incurved, the basal third adnate to the perianth and twice as thick as the distal two thirds; anther-sacs elliptic, introrse more or less pubescent on the inner face; style-rudiment 1, broadly ovoid, blunt, shallowly 3-lobed.

Type, *Gleason 804*, dry sandhills east of Rockstone, deposited in the herbarium of the New York Botanical Garden. Other sheets referred to this species are *Gleason 67*, Tumatumari; *La Cruz 2190*, *2232*, and *Lang 326*, upper Mazaruni River; *Jenman 5800*, Mazaruni River; *Jenman 4736*, Bartica; *La Cruz 2646*, Malali, Demarara River.

The sheets cited show a considerable degree of variation in the length of the pedicel and in the amount of pubescence on the lower leaf-surface, rhachis, pedicel, and anthers, but I have found no definite structural characters upon which to base a division of the species.

The two collections of Jenman have been distributed under the name *D. piperifolia* Willd. Kunth pointed out in his Enumeration in 1850 that this name has been applied to various different species, including *D. polygonoides* H. & B., *Helmia monadelpha* Kunth, and several species of Grisebach's section *Centrostemon*. All of these differ radically from our species in the

structure and position of the stamens or the shape of the perianth. Our species finds its proper position in Grisebach's section *Epistemon*, near the Brazilian *D. dodecaneura* Vell. Among the species of this section, it is distinguished by its pubescent, glandular, punctate-lineate leaves, its simple, pubescent racemes, and its pubescent anthers.

Dioscorea megacarpa n. nom. (*Dioscorea truncata* "Miq.," Schomb. Faun. & Fl. Brit. Guiana 899. *Nomen nudum*. 1848. *Dioscorea truncata* Prain, Kew Bull. **1916:** 194. 1916. Not *D. truncata* Miq. Linnaea **18:** 23. 1844.)

It is probable that the nomenclatorial confusion which has surrounded this species is due to a peculiar oversight in the Index Kewensis, which omitted all reference to Miquel's species of 1844. Miquel's name was applied to *Focke 618*, from Surinam, a plant with deeply 5-lobed leaves, regarded by Pulle as not distinct from *D. trifida* L. f. The name was erroneously applied by Schomburgk to his number *224*, but without description. The description was supplied, and the name first validly published in this sense, in 1916 by Sir David Prain, who also gave a full history of the species and excellent critical notes on its relationships.

The type of *D. megacarpa* remains *Schomburgk 224*, in the herbarium of the Royal Botanic Garden at Kew, where it is also represented by *Sagot 860* and *Jenman 1701*. To these may now be added two collections from British Guiana of more recent date, *La Cruz 2123*, from the upper Mazaruni River, and *La Cruz 3380*, from the Barima River, lat. 8° 20′ N., long. 59° 50′ W. The former exhibits mature fruit of the typical oblong-obovate shape and as large as 50 by 27 mm.

It may be noted that a still more recent use of the name *D. truncata* by Dr. H. H. Rusby for a Colombian species is of course invalid.

Vernonia trichoclada n. sp. Lepidaploa scorpioideae foliatae; plants gregarious, 12 dm. high, herbaceous or suffruticose; stem ascending or erect, simple to the inflorescence, nearly terete, densely and persistently clothed with pale brown, spreading or somewhat deflexed hairs 1.5–2 mm. long, the internodes mostly 4–6 cm. long; petioles 5–7 mm. long, pubescent like the stem; leaf-blades thin, narrowly oblong-elliptic, 10–11 cm. long by 28–30 (rarely 34) mm. wide, gradually tapering or subacuminate to the apex, broadest at or slightly below the middle, broadly

cuneate to the base, entire, above rugose with impressed veins, papillose-pubescent on the surface and densely so on the midvein with hairs as much as 1 mm. long, beneath densely pubescent along the midvein with hairs like those of the stem and softly pubescent on the surface with similar hairs 1–1.5 mm. long; lateral veins about 7 mm. apart, diverging at an angle of 70°, the veinlets conspicuously elevated and reticulate beneath the pubescence; inflorescence a sparsely branched panicle, 30 cm. high, 25 cm. broad as pressed, the branches pubescent like the stem, subtended by rameal leaves resembling the cauline and half as long, the internodes below the heads 5–7 cm. long; heads sessile, more or less secund, solitary, or the lower on each branch paired, separated by internodes 3 cm. long below, gradually reduced to 1 cm. above, or the uppermost heads approximate; bracteal leaves subtending paired heads resembling the cauline in shape, but 3–2 cm. long, those subtending single heads linear or linear-lanceolate, 12–6 mm. long; involucre campanulate, 9 mm. high; involucral scales about 45, loosely imbricate, appressed at the base or the covered portion, all but the innermost irregularly curved-spreading or squarrose above, the outer linear-subulate, 3–4 mm. long, aristate, glabrous within, pubescent without with gray hairs nearly 1 mm. long, the middle narrowly ovate-triangular at base, acuminate from near the base to an awn one-half as long as the scale, villous, the inner narrowly ovate-lanceolate, broadest at one-third of their length, long-acuminate to an awn 1 mm. long, thinly villous, the innermost 6–8 scales ovate-lanceolate, not awned, 8 mm. long, appressed-pubescent; achenes 11, 2 mm. long (immature), densely pubescent with ascending hairs; paleae 25–30, linear-oblong, 0.7–0.8 mm. long, minutely pubescent and fimbriate-ciliolate; bristles about 65, brown, slender, minutely pubescent, 6 mm. long; corolla white, the slender tube 2.7 mm. long, 0.6 mm. wide at the throat, the lobes linear-oblong, 2.8 mm. long, 0.5 mm. wide, acute, minutely pubescent at the apex; anthers linear, 2.1 mm. long, the basal appendages narrowly triangular, acute, 0.4 mm. long.

Type, *Macbride 5775*, collected at the Hacienda Schunke, La Merced, Peru, alt. about 4000 feet, Aug. 27–Sept. 1, 1923, and deposited in the herbarium of the Field Museum (duplicate in herb. New York Botanical Garden).

V. trichoclada appears most closely related to *V. mapirensis* Gleason, of and resembles it very closely in general habit and leaf-form. It differs, however, in its more densely pubescent stem with reflexed hairs, in the quantity and kind of leaf-pubescence, in the larger, more villous involucre, in its squarrose scales with longer aristae, and in the smaller number of flowers in each head.

Vernonia flexipappa n. sp. Stems and branches closely and densely pubescent when young with dark brown hairs, becoming glabrous with age; petioles slender, closely pubescent, 5 mm., long; leaf-blades firm, lance-oblong, 50 mm. long, 15 mm. wide, or the upper smaller, broadest near the middle, sharply acuminate at both ends, entire, minutely puberulent above, becoming glabrous in age, somewhat revolute, silvery beneath with close, very fine tomentum, through which appear appressed brown hairs 0.3 mm. long, veins obscure above, the laterals prominent beneath, about 6 pairs, arising at an angle of 45° and gently curved-ascending, the veinlets concealed; heads 1-flowered, sessile, closely crowded in a terminal, freely branched cluster 5–10 cm. across as pressed and leafless, except at the base of the principal branches; involucre narrowly campanulate, 5 mm. high, its scales about 10, deciduous, regularly appressed and imbricate, strongly curved around the achene, thinly pubescent on the back, the outermost 2.5 mm. long, obtuse, the inner progressively longer and sharper, the longest 4.5 mm. long, 1.3 mm. wide; corolla-tube terete, 2.7 mm. long, 0.5 mm. in diameter, its lobes linear-oblong, acutish, 2.7 mm. long, 0.5 mm. wide; anthers vernonioid, 3 mm. long, including the basal and apical appendages; pappus-bristles pale tawny, 7 mm. long, about 50, fragile and easily detached, with a prominent U-shaped curve about 1 mm. from the tip; a few outer bristles one-half to one-third as long, straight and slender; achenes 2.5 mm. long, dark brown, nearly terete, minutely resinous.

Type, *André 2250*, collected at Loja, Ecuador, and deposited in the herbarium of the New York Botanical Garden. A second sheet in the same herbarium is *André K 1152*, labeled "Loja-Zamora, 1876." The species evidently belongs to the section Critoniopsis, as shown by its 1-flowered heads, its deciduous involucral scales, and essentially uniseriate pappus.

Vernonia trilectorum n. sp. Stem shrubby, finely striate, very densely and closely short-pubescent or subvelutinous with dull brown hairs, the same integument covering the inflorescence, petioles, and principal veins of the leaves; petioles slender, about 10 mm. long; leaf-blades firm, dark green, elliptic-oblong, 9–11 cm. long, 4–5 cm. wide, broadest near the middle, broadly cuneate at base, entire, tapering regularly to a subacuminate tip, upper surface very thinly pubescent with brownish, slender, appressed or ascending hairs 0.1–0.2 mm. long, set 0.1–0.2 mm. apart, becoming nearly or quite glabrous in age, lower surface similarly pubescent, especially along the veins and veinlets; lateral veins conspicuous beneath, 6–9 mm. apart, arising at an angle of 60°, gently curved-ascending, the veinlets reticulate; rameal leaves subtending the principal branches of the inflores-

cence similar, but smaller and narrower, the uppermost only 4 by 20 mm.; inflorescence a freely branched corymbiform cluster, 2 dm. in diameter as pressed; heads 21-flowered, sessile, bractless, 3–5 mm. apart, or the lower more distant; involucre campanulate, 4.5 mm. high; scales about 45, erect or the outer barely spreading when pressed, loosely imbricate, the outermost narrowly triangular-subulate, 1 mm. long, prominently carinate, densely villous throughout, the inner progressively longer, carinate only at the apex, the innermost narrowly lance-oblong, acuminate, not carinate, thinly pubescent; corolla pink, the tube relatively stout, scarcely ampliate, 3 mm. long, the lobes erect, acute, narrowly triangular, 1.6 mm. long; anthers 2.3 mm. long; style-branches slender, tapering, pubescent externally; achenes 2 mm. long, strongly angled, pale brown, densely sericeous with white ascending hairs about 0.2 mm. long; pappus dull brown, the bristles fragile, 4.5 mm. long, slender, rather prominently pubescent, the paleae linear-oblong, 0.5–0.6 mm. long, conspicuously ciliate-fimbriate.

Type, *Pennell, Killip, & Hazen 8556*, collected in thickets at Cuchilla, east of Zarzal, Dept. El Valle, Colombia, alt. 1200–1600 m., 22 July 1922, and deposited in the herbarium of the New York Botanical Garden. Other collections from El Valle are *Pennell, Killip, & Hazen 8555*, same place and date as the type, *Pennell, Killip, & Hazen 8499*, open valley, Quebrada Nueva to Cuchilla, alt. 1100–1300 m., 21, 22 July, 1922, and *Killip 11,232*, woods along stream, "Calima," on Rio Calima, 14, 15 Sept., 1922;—Dept. Caldas: *Pennell, Killip, & Hazen 8692*, stream-bank, Rio Quindio, above Armenia, alt. 1300–1500 m., 25 July 1922;—Dept. El Cauca: *Pennell & Killip 6378*, thicket growth ("machimbi"), Cuatro Esquinas to Rio Piendamo, alt. 1700–1900 m., 6 June 1922, *Killip 6892*, woodland, Coconuco to Popayan, alt. 2000–2500 m., 18 June 1922, *Pennell & Killip 7248*, oak grove, east of Rio Ortega, alt. 1600–1700 m., 27 June 1922, and *Pennell & Killip 8075*, woodland, Rio Ortega to "El Ramal," alt. 1900–2200 m., 2 July 1922.

The description above has been drawn from the type exclusively. Of the other eight specimens, five agree with the type in all essential features, differing only in minor matters, such as the size of the inflorescence and the dimensions of the leaves. In *6892* and *8075*, the paleae are linear and 1 mm. long. In *8555* and *8075*, the leaves are persistently softly pubescent beneath with slender hairs 0.7 mm. long.

Vernonia Pennellii n. sp. Stem and branches terete, finely

striate, densely and softly pubescent or almost velutinous with olive-brown hairs; petioles 12 mm. long, pubescent like the stem; leaf-blades thin, dull green, narrowly ovate-oblong, obtuse or broadly acute at base, entire, gradually narrowed from below the middle to a subacuminate tip, the upper surface very thinly and softly papillose-villous when young, becoming glabrous and rugose at maturity, the lower surface permanently softly villous with very slender hairs 1–1.5 mm. long, lateral veins impressed above, prominent beneath, from 5 mm. apart near the base to 15 mm. toward the apex, ascending at an angle of 60°, gently curved, extending almost to the margin, the veinlets prominently reticulate; inflorescence terminal and from the upper axils, compound, freely and repeatedly branched, 20 cm. wide as pressed, the axes more or less zigzag, the internodes successively shorter distally, the nodes normally bearing 1 terminal head and 2 sympodial branches or 2 heads of different age and 1 sympodial branch; heads very numerous, sessile, 9-flowered; involucre 12 mm. high, its scales about 24, all straight, erect, long-acuminate, loosely imbricate, somewhat spreading when pressed, the outermost narrowly triangular, pubescent, 2 mm. long, the inner linear-oblong or linear-lanceolate, pubescent on the exposed surface, densely so toward the apex, the innermost 11 mm. long, 2 mm. wide; corolla glabrous, pale pink, the tube 6 mm. long, gradually expanded above the middle to 0.8 mm. in diameter at the throat, the lobes linear-oblong, 3.3 mm. long; anthers 3.7 mm. long, including the basal and apical appendages; style-branches 2.5 mm. long, gradually tapering, pubescent externally; achenes (immature ?) stout, 1.6 mm. long, densely sericeous; pappus white, the paleae about 15, 1.8 mm. long, 0.2 mm. wide, acuminate, minutely 1-nerved and ciliolate, the bristles about 60, strongly flattened, somewhat twisted, minutely pubescent, 8 mm. long, 0.1 mm. wide.

Type, *Pennell 2642*, collected in a clearing on a bushy slope, Tequendama, Dept. Cundimarca, Colombia, alt. 2500–2700 m., 28 Oct. 1917, and deposited in the herbarium of the New York Botanical Garden. The specimen consists of two floriferous branches from a shrubby vine. The largest leaf subtends a lower branch of the inflorescence and measures 170 by 55 mm.; the next leaf above it is 145 by 48 mm., and the upper bracteal leaves are much reduced. The species bears no resemblance to any of the other Colombian species known to me.

Vernonia spinulosa n. sp. Stem herbaceous, finely striate, minutely villous above, becoming glabrous below, simple at the base, with several straight, leafy, ascending, floriferous, axillary branches above, the internodes 2–3 cm. long; petiole none or not exceeding 1 mm. in length and tomentose; leaf-blades thick

and firm, lanceolate, 35–40 mm. long, 7–9 mm. wide, long-acuminate to a sharp subulate tip, entire and frequently somewhat revolute, abruptly rounded at base, upper surface dull green, somewhat rugose, pubescent when young, persistently scabrellate with the papillose hair-bases at maturity, lower surface dull gray, densely tomentulose and dotted with elevated black glands; lateral veins mostly 5 or 6 pairs, impressed above, inconspicuous beneath, ascending at an angle of 45°; inflorescence not differentiated; heads 6-flowered, sessile, solitary or occasionally paired, erect or strongly ascending, partly axillary, partly supra-axillary 2–5 mm. above the node; involucre narrowly fusiform, 10–12 mm. high, 3 mm. in diameter; involucral scales about 14, appressed at base, curved-spreading and acuminate into a stiff spinulose apex, sparsely pubescent and ciliate on the exposed portion, glabrous on the covered base and inner surface, the outer lance-subulate, 6 mm. long, acuminate from below the middle, the inner progressively longer and oblong; receptacle with an annular elevation bearing 5 flowers and a central depression with a single flower, glabrous; achenes linear-fusiform, 4 mm. long, shallowly 10-ribbed, with a yellow cartilaginous base, densely hirtellous on the body with ascending hairs 0.3 mm. long; pappus biseriate, the outer paleae about 20, linear, 1–1.3 mm. long, contiguous at base, acuminate, finely pubescent on the outer surface, the inner bristles straight, slender, smooth, pale tawny, 6.5 mm. long, minutely clavate at the apex.

Type, *Pennell 4066*, collected in a thicket at Sincelejo, Dept. Bolivar, Colombia, Jan. 26, 1918, alt. 250–350 m., and deposited in the herbarium of the New York Botanical Garden.

The type specimen exhibits the top of a branching herbaceous plant, devoid of branches for 25 cm., and bearing 5 straight floriferous branches above, each 10–25 cm. long. Heads are developed at the base of all the rameal leaves and also on the opposite side of the axis, at a distance above the axil equal to one third of the internode. Later accessory heads also appear in the axils, but none has reached maturity in the type. The corollas were noted by the collector as red-violet in color, but, like many other species of the genus, the flowers have continued their development after collection and most heads contain only mature achenes. In the few cases where the corollas have persisted, the tube is slender, 4.5 mm. long, not ampliate above, and glabrous; the lobes and stamens have in every case been broken off, but the lobes were apparently minutely pubescent without.

A second sheet, *Pennell 4015*, from similar altitudes at Buena-

Vista, east of Sincé, Bolivar, is fragmentary, but exhibits a few leaves on the basal portion of the stem. These are much broader than the rameal leaves of the type, and as much as 75 by 32 mm. in size.

Vernonia spinulosa is a member of the section *Stenocephalum*, and is most closely related to *V. jucunda* Gleason, of Chiapas, Mexico. It is distinguished from the latter by its narrow rameal leaves, its thinner indument, its larger involucre, achenes, and pappus, and the position of the heads.

Vernonia trichotoma n. sp. Arborescent, 6 m. tall; branches 8-angled, closely ferruginous-tomentose when young, terete and persistently but very thinly tomentulose in age; leaves opposite; petioles 10–14 mm. long, slender, channeled above, tomentulose; blades firm, oblong-lanceolate, 9–12 cm. long, 23–32 mm. wide, broadest near the middle, frequently somewhat falcate, tapering regularly to a blunt tip, entire, long-cuneate to the base, upper surface dark green, glabrous, shining, with finely reticulate, elevated veinlets, lower surface pale brown, densely and softly tomentose, the veinlets obscure; lateral veins diverging at an angle of 45°, strongly curved-ascending, the lower 2–3 mm. apart, the upper progressively wider spaced to 13–20 mm.; inflorescence a compact, terminal, trichotomous, corymbiform cyme, 10 cm. wide as pressed, the lower branches subtended by foliage leaves, the upper bractless (one small bracteal leaf on the type), all closely tomentose; heads 11-flowered, on pedicels 3–7 mm. long; involucre campanulate, 8 mm. high, its scales about 20, closely and regularly imbricate in 3/8 phyllotaxy, erect, obtuse or rounded at the dark tip, densely villous without, sparsely villous within, the outermost minute, the outer broadly ovate, 2 mm. wide, the inner progressively longer and narrower, the innermost linear, 7 mm. long, 1 mm. wide; corolla white, the tube slender, terete, not ampliate above, 3.3 mm. long, 0.5 mm. in diameter, the limb campanulate, the lobes divergently spreading and then curved-ascending, 3.5 mm. long, 0.7 mm. wide, narrowly elliptic-oblong, somewhat constricted above the base, prominently revolute, tapering to the acute apex, villous externally near the tip with hairs 0.3 mm. long; filaments flat, inserted on the throat of the corolla, glabrous; anther-tube pentagonal, 3 mm. long, glabrous, the 5 basal appendages triangular, 0.3 mm. long, the tips ovate-triangular, obtuse, 0.7 mm. long; style branches spreading, filiform, 2 mm. long, pubescent without, channeled within; achenes (immature) 10-angled, dark brown, 3.6 mm. long, minutely glandular; pappus biseriate, the inner bristles pale-tawny, 6.5 mm. long, minutely pubescent, the outer paleae similar, but only 2 mm. long.

Type, *Pennell & Killip 6584*, collected in the forest at "Canaan," Mt. Purace, Dept. El Cauca, Colombia, alt. 3100–3300 m., June 11–13, 1922, and deposited in the herbarium of the New York Botanical Garden.

In general habit, this species is reminiscent of *Critoniopsis Lindenii* Sch.-Bip., but differs in its much larger heads with 11 flowers. It probably belongs to the section *Critoniopsis*, but in its present condition shows no evidence of deciduous involucral scales.

Rapatea linearis n. sp. Acaulescent; leaves narrowly linear, 1 m. long, 10–12 mm. wide, bright green, glabrous; peduncle erect, 1 m. high, glabrous, flattened and prominently winged, increasing in width to nearly 1 cm. at the summit; bracts 2, reflexed, narrowly triangular, 7–11 cm. long, 2–3 cm. wide at the cordate base, tapering regularly to the acute apex, green, glabrous; head depressed-globose, 3–5 cm. in diameter, densely many-flowered; pedicels 3 mm. long, glabrous; bractlets about 14, spirally imbricate, ovate-oblong, the outer 5 mm., the inner 15 mm. long, glabrous, 3–7-nerved, the lower half appressed from the broad base and scarious, the upper half green, outwardly curved and prominently spreading, long-acuminate into a subulate tip minutely spotted with purple; sepals 3, 7-nerved, 16 mm. long, united into a tube and very thin and transparent for 6 mm., the distal 10 mm. stiff, coriaceous, glabrous, yellowish-green, narrowly triangular-lanceolate, tapering to a convolute subulate tip, spreading at anthesis; corolla-tube 10 mm. long, very thin and transparent, faintly nerved; petals 3, yellow, membranous, ovate, 12 mm. long, 7 mm. wide, abruptly acuminate into a short tip, widely spreading at anthesis; stamens 6, inserted on the corolla-tube 1.5 mm. below its summit; filaments transparent, 1.5 mm. long, incurved and then erect; anthers linear-subulate, 5 mm. long, cordate at base, 2-celled, white below, tapering into a gently curved, yellowish-brown appendage, marked with a central, introrse, elongate cleft expanding at its base into a circular pore; ovary subglobose, 3 mm. in diameter; style slender, 14 mm. long.

Type, *La Cruz 3931*, collected along the Wanama River, Northwest District, British Guiana, and deposited in the herbarium of the New York Botanical Garden; a second collection is *La Cruz 4293*, from Assakatta, Northwest District.

Easily distinguished from *R. paludosa* Aubl., the common species of the Guianas, by its narrower leaves, shorter pedicels, and narrower, regularly tapering bracts.

Bihai sylvestris n. sp. Stems erect, 12 dm. high; leaf-sheaths glabrous; petiole of the uppermost leaf 5–20 mm. long, of the second leaf 20–50 mm., glabrous; leaf-blades green and glabrous on both surfaces, narrowly lanceolate, 25–51 cm. long, 3–8.5 cm. wide, long-acuminate, rounded or subcordate at the base; peduncle exserted 11–33 cm. beyond the uppermost leaf, straight, erect, glabrous or somewhat glaucous distally; bracts 5 or 6, widely spreading, linear, straight, glabrous, conspicuously glaucous, the lowest 13–18 cm. long and sometimes expanded at the apex into a flat, lanceolate-oblong lamina, the upper uniformly reduced in length to 2–3 cm.; rhachis flexuous, glabrous, glaucous, the internodes 3–4 cm. long or the uppermost shorter; bracteoles glabrous, scarious, brown, 15–20 mm. long; flowers 5–10 in each bract, on glabrous pedicels 1–2 cm. long; corolla scarlet, 5 cm. long.

The herbarium of the New York Botanical Garden contains five specimens, all from forests or thickets at Tumatumari, British Guiana: *Gleason 5, 82, 105* (type), and *937*, and *Hitchcock 17,347*.

Bihai sylvestris seems to be most closely related to *B. acuminata* (Rich.) Kuntze, a common species in British Guiana, but differs from it and from the other species of the region in its shorter petioles, narrower leaf-blades broadly rounded at the base, and heavily glaucous bracts.

Renealmia pedicellaris n. sp. Sterile stems 12–15 dm. high, 1 cm. in diameter, plagiotropic; leaf-sheaths strongly striate, somewhat reticulate, scabrellate on the ribs, the ligule rounded, 2 mm. long, pilose with brown hairs; leaf-blade oblanceolate, 48 cm. long, 8.5 cm. wide, abruptly acuminate, somewhat cartilaginous on the margin, tapering to an unsymmetrical base, glabrous on the surface, the short petiole (1 cm. long) and lower part of the midvein more or less pubescent; flowering stems prostrate, 4–8 dm. long, the lower half sterile, bracteate, the bracts oblong, sheathing, covering two-thirds of each node, glabrate below, pubescent at the tip; panicle narrowly oblong, the bracts, bractlets, rhachis, and pedicels pubescent; flower-clusters about 1 cm. apart, 3–5-flowered; common pedicel 3–6 mm. long; pedicels 1–3 cm. long, thickened distally, 3–5 mm. apart; fruit subglobose, blue-black, 10 mm. in diameter, strongly nerved, puberulent when young, becoming glabrous with age, 9-seeded, each three seeds surrounded by a scarious aril; seeds brown, 3 mm. in diameter, calyx persistent, campanulate, 4–5 mm. long, puberulent to glabrous, irregularly torn or with several short terminal teeth.

Type, *Gleason 138*, collected in dense upland forest, Tumatumari, British Guiana, and deposited in the herbarium of the

New York Botanical Garden. The bracts have mostly disappeared, but are apparently linear-lanceolate and about 15–20 mm. long. The bractlets are of the same shape, about 10 mm. long, and much surpassed by the unusually long pedicels.

Renealmia pedicellaris is apparently related to *R. occidentalis* (Swartz) Sweet and to *R. orinocensis* Rusby. From the former it differs in having fewer flowers in a cluster, on much longer pedicels; from the latter in its much shorter clusters. It may be still more closely related to *R. floribunda* K. Schum., and closely resembles the plate of that species in Flora Brasiliensis under the name *R. occidentalis* var. *longipes* Peters., but differs in its larger panicles and fruit and in its much more copious pubescence.

Renealmia pilosa n. sp. Sterile plant 10–15 dm. high, with 10–15 alternate leaves; leaf-sheath glabrous, striate, the ligular lobes truncate or rounded, 2 mm. wide, pubescent externally; leaf-blades sessile or on petioles 3–10 mm. long, oblong-lanceolate, 51 cm. long by 8 cm. wide, or smaller, abruptly acuminate, scarious on the margin, tapering at base, glabrous; flowering stems more than 4 dm. long; peduncle glabrous or finely and sparsely pilose, covered with erect, appressed, sheathing scales which are 10 cm. long, minutely pilose basally, and glabrous toward the apex; panicle 25 cm. long, the rhachis finely pilose; bracts narrowly linear-lanceolate, obtuse, pilose externally near the base, otherwise glabrous, the lower as much as 5 cm. long, the upper gradually reduced, the uppermost only 1 cm. long; clusters mostly 2–3-flowered, on a pilose common pedicel 3–10 mm. long; bractlets broadly ovate-campanulate, 1 cm. long, pilose on the back near the base; pedicels 5–10 mm. long, nearly glabrous; ovary broadly ellipsoid, glabrous, 5 mm. long; calyx turbinate-campanulate, 6 mm. long, with 3 rounded lobes, pilose near the base, pubescent or subtomentose at the apex.

Type, *H. H. Smith 2318*, collected at Don Amo, Santa Marta, Colombia, altitude 1600 feet, and deposited in the herbarium of the New York Botanical Garden. The collector notes that it is local in damp thickets and produces yellow flowers in June, followed by red berries turning black at maturity and with a strong fruity odor. *André 2014*, from Ibagué, and *Pennell, Killip, and Hazen 8513*, from Cuchilla, Department of El Valle, may also be referred here.

Renealmia pilosa is obviously of Schumann's series Scaposae, subseries Paniculatae, although the basal location of the inflorescence is not shown on the three specimens cited. Within

this group, it is related to the Antillean *R. occidentalis* (Swartz) Sweet, and apparently also to the Colombian *R. Lehmannii* K. Schum., which I have not seen. It differs from the former in its few-flowered clusters, and from the latter, according to Schumann's careful description, in the conspicuous pilose pubescence of the rhachis, pedicels, bracts, and calyx.

Ischnosiphon foliosus n. sp. Stem 6–9 dm. high, simple, leafless below, bearing leaf-scars above and at the summit about 8 crowded leaves separated by internodes 3–4 mm. long; leaf-sheaths 7–10 cm. long, glabrous, the membranous margins 3 mm. wide, tapering to the apex, not auriculate; petioles 11–40 mm. long, the basal portion strongly angled, glabrous, the distal 7–14 mm. somewhat swollen, terete, minutely roughened; leaf-blades ovate-lanceolate, 11–16 cm. long, 3.5–6.5 cm. wide, obtuse or rounded at the base, abruptly short-acuminate, the point somewhat excentric to the right, glabrous on both sides, midvein extending three-fourths the length of the blade, the lateral veins strongly ascending; inflorescence single from the upper axils; peduncle 8 cm. long, erect, strongly angled, glabrous; spikes 2, 7–12 cm. long, terete or nearly so; bracts appressed, cymbiform, embracing the rhachis, ovate, 30–35 mm. long, acuminate, separated by internodes 10–13 mm. long, finely striate, glabrous; first and second bractlets linear-oblong, the third filiform, clavate-thickened at the apex, all 3 cm.long and equaling the linear glabrous sepals; capsule oblong-obovoid, 2 cm. long, villous, especially at the summit.

Type, *Gleason 721*, collected in dense upland forest, Tumatumari, British Guiana, and deposited in the herbarium of the New York Botanical Garden; also *Gleason 176*, from the same locality.

In several respects this species is remarkable in comparison with the other species of the genus. In its closely crowded and regularly distichous leaves it approaches *I. Martianus*, the only species hitherto described with such an arrangement. It differs from it in its petiole, which is callously thickened only at the summit, in its glabrous bracts, and in its proportionately wider and shorter leaves. In my dissections I have found but a single flower for each bract; if this character is constant, it is unique for the family Marantaceae.

AFRAMOMUM MELAGUETA (Rosc.) K. Schum. (*Amomum melagueta* Rosc.). The type locality for this African species is British Guiana, whence specimens were sent by Parker a century ago. Recent collections (*La Cruz 1148, 1250, 3310, 3327, 4034*)

show that it is still widespread and perhaps naturalized in that country.

CALATHEA CYCLOPHORA Baker. This species, based on *Appun 252*, from British Guiana, is represented in recent collections by *Hitchcock 17,321* and *Gleason 577* from Rockstone, *La Cruz 1522* from the Rupununi region, *Lang 245* from the upper Mazaruni river, and *La Cruz 2913*, *3127*, and *3658* from the northwestern coastal region. Schumann erroneously refers it to Mexico in his treatment of the genus in the Pflanzenreich.

Dupatya roraimae (Oliver) n. comb.

Paepalanthus roraimae Oliver, Trans. Linn. Soc. II. **2**: 286. *pl. 49 B, f. 7–14.* 1887.

Dupata Karstenii (Ruhl.) n. comb.

Paepalanthus Karstenii Ruhl., Pflanzenreich 4^{30}: 155. 1903.

Pennell 2256 and *2685A*, from paramos near Bogota, Colombia, have been tentatively referred to this species.

DUPATYA PILOSA (H. B. K.) Kuntze. *Holton 122*, collected near Bogota, was referred to this species by Hochreutiner, and *Pennell 1997*, from the same vicinity, seems to be the same in all essential respects. *Pennell 2074*, also from paramos near Bogota, has shorter, more rigid, and more densely pilose leaves, bracts 3 mm. long, and petals of the pistillate flower oblong-oblanceolate and fully 2 mm. long. In the two sheets of *D. pilosa* cited above, the bracts are only 2 mm. long and proportionately much broader and the petals are broadly triangular-dilated above the narrow oblong base. Pennell's specimen may represent an undescribed species, but should be compared with Humboldt's types before any final conclusion is reached.

The genus *Gnetum* is represented in recent collections of La Cruz by three numbers, illustrating three distinct species, of which one is hitherto undescribed. They may be separated as follows:

Veinlets (examined by transmitted light) conspicuously reticulate, the areoles 0.2–0.3 mm. in diameter; leaves elliptic, broadest near the middle, broadly obtuse at base, rounded to an apiculate apex (*La Cruz 4311*) . . . *G. paniculatum* Spruce

Veinlets indistinct, not reticulate; leaves of an ovate type, broadest below the middle, more gradually tapering to an acute or abruptly acuminate apex.

Leaves elliptic-ovate, twice as long as wide, rounded at base; axis of the staminate inflorescence s ender, not swollen immediately above the insertion of the sporophylls (*La Cruz 3522*)..... *G. nodiflorum* Brongn

Leaves broadly ovate or subrotund, a third to a half longer than wide, broadly rounded or subcordate to an abruptly short-cuneate base; axis of the staminate inflorescence prominently swollen immediately above the insertion of the sporophylls, the latter borne on a horizontal disc (*La Cruz 4222*) *G. Cruzianum*

Gnetum Cruzianum n. sp. Stems woody, climbing 6 m.; petioles stout, 10–12 mm. long, strongly bicarinate above; leaf-blades broadly ovate or subrotund, as large as 13 cm. long by 11 cm. wide, coriaceous, dull-green above, brown-green beneath, glabrous, gradually rounded from below the middle to a subacuminate or triangular-apiculate apex, broadly rounded or subcordate below to a short-cuneate base; lateral veins 4 or 5 pairs, ascending at an angle of 45 degrees, faintly arcuate and anastomosing at two-thirds of the distance to the margin; secondary veins faint, barely impressed above, irregularly anastomosing, almost invisible on the lower surface; veinlets indistinct; staminate inflorescence paired in the upper axils, simple or sparingly branched, 10–15 cm. long, flexuous, the nodes 10–20 mm. long; involucre hemispherical, 5 mm. in diameter; internodes sterile and densely villous within the involucre on the basal 2 mm., then expanded into a spreading, subhorizontal, floriferous disc 3 mm. in diameter, strongly swollen and tomentose immediately above the disc.

Type, *La Cruz 4222*, collected at Kamakusa, on the upper Mazaruni River, British Guiana, and deposited in the herbarium of the New York Botanical Garden. The swollen portion of each floriferous internode, with its accompanying tomentum, is visible above the sporophylls.

A study of progressive cell plate formation*

BESSIE GOLDSTEIN

(WITH ELEVEN TEXT FIGURES AND PLATE 6)

In connection with a study of the cells of the meristem and protoderm of the growing tips of healthy tobacco plants and those affected with mosaic disease, I have had occasion to study division figures in cells which are already more or less vacuolated.

Treub (**23**) seems to have been the first to point out the peculiarities of cell division in large vacuolated cells having a very thin parietal layer of cytoplasm, the primordial utricle. His figures show clearly that nuclear division and cell division are distinct processes in the life of the cell. He points out too that cell plate formation is a progressive process and that the cell plate widens gradually thus cutting across the cell protoplast and dividing it into two. Only when the cell plate reaches the walls of the mother cell, are there two distinctly separated daughter cells.

Stages in the formation of the cell plate have been figured in many studies of cytokinesis, but these figures have generally represented a side or lateral view of the division figure. This is because the material is generally cut longitudinally, and the sections presented views perpendicular to the cell plate. Cross sections of growing tips presenting polar views of cells in division stages in my material, show the cell plate development in aspects which, as will be noted later, are easily misinterpreted. Rings of kinoplasmic material appear to encircle two nuclei which often can be seen lying more or less directly over one another, or overlapping. Sometimes it is necessary to focus carefully to distinguish the fact that there are two nuclei present. This gives the appearance of a binucleate cell with a halo. The ring or halo of granular or fibrillar material is the phragmoplast or fibrillar complex seen in polar view.

Such polar views of late cell plate formation were figured by Went (**24**) in cells of the endosperm of *Fritillaria imperialis*. In his *plate 11, fig. 17*, a cell division figure in polar view, shows

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the kinoplasmic fibrillar ring with a single nucleus. In *fig. 18*, the fibrillar complex has become separated into two arcs as a result of the fusion of the lateral portions of the ring with the walls of the mother cell. Strasburger (**19**) also shows an excellent polar view of cell plate formation in an endosperm cell of *Fritillaria imperialis*. This is in *plate 2, fig. 20*, where the ring of kinoplasmic fibrils lies in a large polygonal cell, and a single nucleus only is present in the section. Němec (**12**) shows several polar views (*figs. 15, 17*) of early stages in cell plate formation in the cells of the wound periderm of the potato tuber.

Prankerd (**14**) records the occurrence of multinucleate cells in various undifferentiated tissues of immature vegetative organs, and believes the many nuclei arise by amitosis.

Beer and Arber (**4**) from their studies of growing tissues in a large number of plants, conclude that the occurrence of multinucleate and binucleate cells is very common, and that the many nuclei arise in all cases by means of mitotic division. They ascribe the binucleate condition to certain peculiarities of cell division, by which a so-called phragmosphere may cut off a central cell containing two or more nuclei from a bounding cell, the remainder of the mother cell, which has no nuclei.

My own observations show clearly that in the case of the growing tips of tobacco plants, no such binucleate cells are formed. and that cell division in every case proceeds quite normally. The report of binucleate cells and the peculiarities of cell division referred to are the result of a failure to take into account the appearance of ordinary cell division figures when seen in polar view or when oblique to the plane of the section, and also apparently a failure to focus carefully in order to determine the correct relative position of the young daughter nuclei.

The multinucleate condition in which great numbers of nuclei are seen in a single cell should not be associated at all with the supposedly binucleate condition discussed by Beer and Arber. The problem as to what this multinucleate condition signifies and why it is found in the cells of the plants studied certainly needs careful investigation.

Bailey's (**1**) statement in regard to multinucleate cells commonly believed to be present in such elongated cells as the cambium initials, shows that the apparently multinucleate condition in such cases, may simply be due to a failure of the

observer to realize that the thickness of the section may include parts lying at entirely different levels and in different cells. He states that in tangential, longitudinal sections of the cambium, the elongated initials frequently appear to be multinucleate, due to the fact that several radially flattened cells are exactly superimposed so that their nuclei lie quite close to the same focal plane.

Hutchinson (**8, 9**) finds that in the pollen grains of *Abies* and *Picea* the mitotic division of the central or primary cell nucleus is not followed by the ordinary cell plate formation, but by what he calls a form of free cell formation. The generative nucleus becomes enclosed in a hollow cylinder of fibers, the remains of the central spindle, which fuse lengthwise side by side, cutting the generative cell out of the primary cell, and leaving the tube nucleus in the cytoplasm of the original primary cell. In the light of my studies however, it seems to me that his figures show that cell plate formation is proceeding in the usual way by the formation and thickening of additional fibers at the periphery of the cell plate already formed from the central spindle, and that his claim that free cell formation occurs in these cases has arisen from a failure to interpret correctly polar and oblique views of his division figures.

We have relatively few studies of division figures as they occur in large vacuolated cells where the cytoplasm during the resting stages is found in the form of slender threads and broader strands and films cutting through the protoplasts in all direction. The nucleus may lie suspended anywhere in such a system. Treub's (**23**) original figures of cell plate formation include cases of division in such large vacuolated cells as those of the ovule cells of *Epipactis palustris*, the fundamental tissue of young flowers of *Iris pumila*, internodal cells of *Chrysanthemum leucanthemum*, and various other plants. His figures in *plate 4* show typical cell plate formation in such cells as seen from the side and as ordinarily figured. Beer and Arber's (**4**) studies also dealt with cell plate formation in large more or less vacuolated cells, but as noted they seem to have interpreted incorrectly sections cut parallel to the forming cell plate.

In my studies young tips of vigorously growing tobacco plants about eight inches high were cut off from both healthy and mosaic infected specimens. The material was fixed in various

fixing solutions—chromo-acetic, Bouin's solution, Allen's modification of Bouin's method, both hot and cold, Němec's chrom-formalin method, and the different strengths of Flemming's solutions. I find that Allen's modification of the Bouin method, fixed either at 38° C., or even at ordinary room temperature, and Flemming's weak solution are the best for the study of nuclear and cell divisions in this material. Cross and longitudinal sections were cut for study. The sections were cut 10 microns thick and stained with Flemming's triple stain.

I have studied cells of the tip as well as those occurring in the very young leaves or leaf primordia forming below the tip. These cells are characterized by large vacuoles, across which run strands of cytoplasm of varying size and form. A very thin layer of cytoplasm, the primordial utricle, lines the walls. The nucleus may lie against a wall, or hang suspended in the cytoplasmic strands. The plastids are found in the strands of cytoplasm, and stain a deeper orange than the cytoplasm, and when they contain starch, the starch grains are bright blue in the orange plastid. The young cell plate immediately after formation appears blue, while the young cell walls are thin and take a very faint orange stain. Older walls take a deep orange stain.

In cells of the meristem that are about to divide, the cytoplasm seems to be more than ordinarily massed around the nucleus. The plastids are often also grouped in this dense cytoplasmic mass about the nucleus, though a few scattered ones may remain in the primordial utricle. A region of yellow staining granular material is often found around the dividing nucleus, and this may be the source of the kinoplasmic material soon to appear in the division stages. This granular material is often visible around the spindle and at the poles during later division stages. The polar caps appear at the spireme stage, and consist of fibrils grouped in the form of a cone enclosing a clear space within them. I shall not discuss the problems of spindle formation and the anaphases, as my material presents nothing specially significant for these stages.

During the telophases, the two daughter nuclei are reconstructed, the nuclear membrane is formed, the nucleoles appear, and the chromatin is distributed in the form of more or less rounded chromatin bodies resembling very much prochromo-

somes as described by Rosenberg. The daughter nuclei immediately after division present quite a different appearance from the nucleus of a cell in the so-called resting condition. They stain very deeply. The nucleoles if present are very small, and the chromatin, as noted, is in the form of small bodies lying in a less deeply staining nuclear sap.

A casual examination of cross sections of such tobacco tips would suggest that binucleate cells are not infrequent just as Beer and Arber (4) describe them as occurring in some 177 species of plants. More study shows that the two nuclei which appear to be in one cell, are in fact separated by a cell plate which is parallel or almost parallel to the plane of the section and is thus easily overlooked. I have observed this condition very often in my sections cut ten microns thick, where here and there in the section a cell will appear more intensely stained than neighboring cells. The appearance of two nuclei apparently within the boundaries of such a single cell, is confined entirely to these more deeply staining cells, the dividing walls of two superimposed cells both lying within the section.

In the growing tips of stems, we find a terminal meristem, the growing tip itself, made up of very small polygonal cells whose large nuclei nearly fill the cell, and which are dividing rapidly. Below them there is a region of elongating and enlarging cells, containing large vacuoles through which run thin strands of cytoplasm supporting a nucleus which appears small in comparison with the size of the cells. Division figures in abundance are found here also because the shoots are increasing in thickness. Such a region furnishes excellent material for the study of cell plate formation in large vacuolated cells.

In the cells of the growing tip of tobacco, in the early telophases, the central spindle is as usual barrel shaped. It next widens laterally in the ordinary fashion and changes rapidly from barrel to biconvex lens shape (PLATE 6, FIG. 1). The daughter nuclei in the cells of the tobacco meristem follow the apparently shortening fibers toward the cell plate as it is formed so that no clear space is left between the shortened fibers and the nuclei (FIG. 2). With the completion of the cell plate midway between the daughter nuclei the familiar fiber complex still remains.

The fibers at this stage curve toward and may be connected

with the daughter nuclei. As the cell plate increases in diameter, and the fiber complex gradually moves outward in all directions the threads finally lose all connection with the daughter nuclei, as is shown clearly in longitudinal section (FIG. 2).

This figure shows a long thin line (edge view of the cell plate) in the equatorial region between the two daughter nuclei, while at each end of the line, and more or less at right angles to it, appears the familiar mass of fibers with their ends still curved in toward the daughter nuclei. In terms of the kinoplasm theory, division here is by means of a progressively peripheral development of kinoplasmic material which is adding to the cell plate on its periphery, new kinoplasmic fibrillar material appearing continually in a centrifugal direction, on the outside. The cell division then is by a process of centrifugal development of the original so-called central spindle. The nature of this process has been the subject of much discussion. Bailey's (**1, 2**) very striking discovery that even in the long, thin, and narrow cambial cells this same peripheral spread of a fibrillar system from the region between the daughter nuclei to the extreme ends of the dividing cell occurs, emphasizes most strongly the apparent importance of fibrillar elements in this most important process in cell reproduction.

Bailey (**2**) describes and figures such cell division stages in the cambium initials: "Fusiform initials, which frequently are several hundred times as long as they are wide, divide longitudinally by an extraordinary extension of the cell plate." In certain Gymnosperms for example, the cambium initials may attain a length of more than 9000 microns. These cells are uninucleate, so that "the working sphere of their nuclei must extend in certain cases for a distance of several thousand microns."

His description of the stages of cytokinesis in these extremely elongated cells agrees in principle with what takes place in vacuolated cells. The central spindle expands marginally by the addition of peripheral fibers which thicken, shorten, and finally fuse to produce the cell plate material. They thus constitute a circular rim of fibrillar kinoplasm which appears as a halo about the portion of the cell plate already formed, when seen in polar view. The ring can only increase in circumference in narrow tangentially cut cells until it intersects the radial walls.

The lateral portions of the ring then disappear as the cell plate in these regions reaches the radial walls, leaving two separate arcs of kinoplasmic fibrillae to continue their progressive movement to the farther regions of the cell. They thus extend the cell plate lengthwise through the cell. These two separate kinoplasmic arcs, Bailey believes are distinctly characteristic of elongated or perhaps also much flattened cells, and he gives the name kinoplasmosomes to them.

The term phragmoplast to designate the central spindle and its widening out into a fibrillar halo surrounding the cell plate, is rather misleading, since it seems to associate the activity of cell division with such other cell processes as are associated with chloroplasts, leucoplasts, elaioplasts, etc. There is no real functional analogy here to warrant the use of the term plast or body. There is no definite organ of the cell especially concerned with the production of kinoplasmic fibrillar material. It is rather a particular period in the life of the cell which is to be characterized. Starting with the prophases of karyokinesis, and proceeding on through cytokinesis, the metabolic activity of the cytoplasm and nucleus are directly concerned with these kinoplasmic activities. As will be noted below, the fibers appear in the cytoplasm along the periphery of the cell plate. The daughter nuclei lying close to the plate, and connected by cytoplasmic strands along the cell plate to its peripheral edge, may also be concerned with the production of the fibrillar material.

There is an objection to the term kinoplasmosomes proposed by Bailey (1) to designate the two parts of arcs of the kinoplasmic fibrillar ring, which have not yet reached the walls of the mother cell, as figured in his *plate 29, figs. 54, 57,* and *58*. Such separated portions of the kinoplasmic ring may arise for various reasons such as the irregular shape of the cell, or the position of the dividing nucleus as it may lie on one side or in a corner of a vacuolated cell.

Treub (**23**) in his study of the formation of the cell plates of cells containing large vacuoles, notes two modifications of the process according to the type of cells concerned. If the nuclear division has taken place in the center of the cell, then the formation of the plate takes place symmetrically and progressively outward in all directions reaching the cell boundary at

all points simultaneously. If, however, the nuclear division has taken place nearer one side of the cell than the other, then the cell plate reaches the nearer side of the mother cell wall first. The remaining oppositely placed portion of the phragmoplast continues its development toward the farther side of the cell. The splitting of the plate and the formation of the cellulose membrane between may take place on the completed side before the fibrillar complex has reached the opposite side (*plate 4, figs. 35, 40, 42,* and *43*). In the latter case, Treub observed that the daughter nuclei in living cells (*plate 3, figs. 12a–12h*), may move out along with the moving phragmoplast across the cell, thus giving evidence of their direct relation to the development of the fibrillar complex and the formation of the cell plate.

I have found (FIG. 4) as Strasburger did (**17,** *plate 7, figs. 30, 31*) that the daughter nuclei may remain at one side of the cell, close to the finished cell plate, while a portion of the phragmoplast develops progressively across the rest of the cell, thus reaching a position at a considerable distance away from the nuclei. This does not mean that the nuclei are not directly concerned with the further growth of the cell plate. In such cells the nuclei seem always to maintain a position equidistant from all parts of the greatly extended arc of kinoplasm. According to the figures I have observed in my sections, the size of the cell, in such cases is usually greater than in the cases in which the daughter nuclei migrate with the development of the cell plate and in which hence, the kinoplasmic ring usually has a smaller radius.

However, as I have stated before, the generally symmetrical position of the two nuclei with reference to the cell plate, and the fact that the cytoplasmic reticulum has at this time developed outward from the region of the daughter nuclei across the cell and along with the newly forming cell plate, provides that the fibrillar complex is still in definite cytoplasmic continuity with the nuclei.

Instances of the great distance to which the developing portions of the phragmoplast may go through the length of a very elongated narrow cell, are to be found in young sieve tubes, companion cells, procambium cells and other elongated vascular elements, in my sections through young petioles and the midribs of tobacco leaves. The figures confirm those of Bailey in all respects.

The movement of the daughter nuclei toward the cell plate and each other, bringing with them the cytoplasmic reticulum, is a conspicuous fact whose significance is not at all clear. This arrangement may simply provide for passing the "energizing" influence of the nuclei along the cytoplasmic strands to the region of fibril formation and growth about the periphery of the plate.

The most important typical figure of all the interrelations between daughter nuclei, general cytoplasm, fibrillar complex, and forming cell plate is probably to be found in such dense protoplasm as is found in pollen mother cells, root tip cells, etc. Timberlake's (**22**) *figs. 6*, *7*, and *8* of larch pollen mother cells, may be taken as such type figures. The whole cell division process involves a somewhat biconvex lens shaped region in which the daughter nuclei lie at the centers of the two faces of the lens and within its surfaces. The periphery of the lens is rounded and the curves of the elements of the fibrillar complex if continued would follow the surface of the lens figure and thus converge on a point occupying a position in the equator of the daughter nucleus. The longer fibers are on the periphery, and they shorten and fade out imperceptibly with the substance of the cell plate.

A conspicuous feature of this lens figure is that, with the exception of the elements mentioned—daughter nuclei and fibrillar complex, it appears quite devoid of stainable material. The cell plate appears as a thin line bisecting the whole figure. It is this absence of stainable material on both surfaces of the cell plate which suggests so positively that its material has been derived from the fibers which once filled this space.

The important rôle of the nucleus to various cell activities has been pointed out in many connections. In *Tradescantia* stamen hair cells, the circulating cytoplasmic threads are continually changing their position, swinging across the cell lumen through the cell sap, fusing with one another, etc. However, the prevailing direction of the streaming, as first described and figured in 1838 by Meyen (**11**), is to and from the nucleus.

Haberlandt's (5) description of the position of the nucleus in the developing root hairs is a familiar case. Here the nucleus lies right in the region of the first outward bulging of the epidermal cell wall, and moves out with the dense cytoplasmic material as the root hair grows in length.

Harper (6) concludes that the nucleus is the center of the activities concerned in forming the kinoplasmic fibers that bound the spore in free cell formation in the ascus, the special locus from which the fibrils develop being the central body on the surface of the nuclear membrane. That the nucleus is directly concerned in this formation of kinoplasmic material and the process of cell formation, is suggested by the fact that it is drawn out in the form of a long beak at whose tip is the active astral system. The ultimate fusion of the fibers side by side as their material flows down about the nucleus, results in the formation of an enclosing cell membrane.

Strasburger (19) holds that in cells with vacuoles, the laterally adjacent cytoplasm is soon drawn out into a thin sheath which surrounds the two daughter nuclei and encloses the fibrillar complex. Such a connecting sheath is not found in pollen mother cells of larch which are densely filled with cytoplasm, where however, the relation of the inner boundary of the surrounding cytoplasm with the fibrillar complex is the same. His *figs. 17* and *18*, *plate 2* (19) illustrate the shortening of the fibers of the central spindle to form the cell plate. *Fig. 19* shows the drawing back of the peripheral primary fibers from the cell plate already formed, thus drawing out the surrounding cytoplasm into a sheath around the spindle and the daughter nuclei. *Fig. 20* shows the same stage in a polar view. In *fig. 21*, the cell plate has reached one wall, while still continuing its movement across the mother cell on the opposite side. Here the cytoplasmic connection of the growing fibrillar complex and the daughter nuclei is clearly demonstrated. In *fig. 22*, the daughter nuclei in the completed daughter cells are shown once more suspended on radiating strands of cytoplasm.

The old question was whether new threads arise from the splitting of the old threads or *de novo*. If the threads are paths of flowage one could hardly admit of their splitting to form new threads. Such ideas as the threads giving rise by a splitting to new threads, or by a transfer of some of their substance into shorter threads first appearing between the longer threads, seem scarcely possible. The most satisfactory and reasonable explanation of their origin, is that they arise *de novo* in the cytoplasm about the periphery of the cell plate where they are being used up in its formation and growth.

The well known cytoplasmic aggregation around the nucleus that I have described as present in the early prophases, and often evident all through the stages of division, including the formation of the cell plate, is the notable feature in cell organization during the division stages. This is especially the case in highly vacuolated cells. Strasburger (**19**) describes this condition very clearly. It suggests without doubt that a relatively compact unit area, including both nuclei and cytoplasm, must be developed antecedent to the metabolic changes which lead to the formation of the kinoplasmic fibers in the polar caps, and later in the widening of the central spindle and the growth of the cell plate.

The rôle of the nucleus and later the daughter nuclei in these processes is by no means clear but it is fair perhaps to assume, that here, as in the other familiar cases noted above, it is in some way the centre of the metabolic changes which are taking place.

The relation of this cytoplasmic mass to the formation of the fiber groups and hence to the formation of the cell plate has not as yet been at all adequately cleared up, but the rearrangements in preparation for division which take place in much vacuolated cells and especially those with a single large central vacuole suggest its great importance.

Timberlake's (**22**) conclusion that the fibers can only arise in connection with the nucleus is in harmony with the facts as seen in cells of onion root tips, and larch pollen mother cells, where the peripheral threads of the spindle seem scarcely to lose their direct communication with the daughter nuclei through the whole development of the cell plate. The biconvex lens shape (Timberlake figures in *plate 8, figs. 6, 7, 8*) assumed by the fiber system in its late stages, emphasizes this conception.

In such vacuolated cells as I have studied, and for Bailey's procambial cell division, the case as to the origin of the new fibers at the periphery of the widening cell plate is not so clear. Bailey's figures are remarkable illustrations of the great extent to which the fiber complex must move in building the cell plate. Bailey (**1**) states, "The threads or 'lines of flow' do not extend across the cell from one tangential membrane to the other, but lie free in the cytoplasm. Nor are they connected with the daughter nuclei which remain in their original position near the center of the protoplast." "There is an enormous increase in

the number of 'peripheral' fibers during cytokinesis." "The phenomena appear to justify Strasburger's contention that the accessory fibers are of cytoplasmic origin."

If the fibers mark lines of flow, however, it is not impossible that in all these cases the form of the individual fibers is important. The fibers in my figures always curve inward toward the daughter nuclei, not only after they have lost all connection with the nuclei, but even when the fibrillar complex has migrated to a considerable distance across the cell away from the nuclei in those cases where the daughter nuclei have not accompanied the growing phragmoplast.

In my opinion, Beer and Arber's description of a new type of cell division by means of a "phragmosphere," the formation of a cell within a cell, the binucleate condition of this enclosed cell, and the cutting off of a cell without a nucleus are all based on a misinterpretation of polar views of the ordinary stages of cell division in vacuolated cells.

As I have explained, the "phragmosphere" is simply a polar view of a stage in progressive cell plate formation. The nuclei are not both left in the same cell, but one lies above, the other below the cell plate which is being formed within the kinoplasmic ring. There will be no cutting off of a cell without a nucleus since the ring of fibers will move out to the peripheral wall and cut off completely a lower and upper cell, not a cell within a cell as Beer and Arber describe.

Bailey (3) in a note on "Phragmospheres and binucleate cells" suggests that these investigators are simply describing stages in the division of parenchymatous cells, and that they present no evidence for the resorption of the central spindle without the formation of a cell plate, or the transformation of the phragmoplast with the associated cytoplasm into a hollow sphere, which will increase in diameter and form a hollow shell or cell within a cell. He (1) has correctly referred their description of such stages as they show in *figs. 1* and *20* to his *fig. 56, plate 29*. He interprets the situation as showing the wide view of the moving sphere of kinoplasm which has moved out from its original position between the two daughter nuclei, in *fig. 55, plate 29*. In *fig. 56*, we have the polar view of a similar stage where the circle of kinoplasmic material is in view as it lies between the two nuclei. The nucleus shown in *fig. 56*, appears

to lie above the sphere. In *fig. 57*, the two nuclei are visible, though situated at different levels in the section. The kinoplasmic complex here has reached the side walls of the cell and completed the cell plate in this region. Above and below, it continues building the cell plate which really extends from one arc of kinoplasm to the other, and lies between the two nuclei. A comparative study of longitudinal and cross sections demonstrates that such a plate actually does exist and is present even though indiscernable in a polar view.

Hutchinson (**8, 9**) also describes certain peculiarities existing in cell plate formation in the male gametophytes of *Abies* and *Picea*. The peculiarities referred to are in connection with the division of the primary cell to form a generative cell and tube nucleus. He claims that although thickenings of the fibers do occur in late telophase, yet no well defined cell plate is formed, but as the spindle begins to grow wider, it moves away from the tube nucleus, finally enclosing the generative nucleus only in a globe of fibers, as in his *figs. 11* and *12* (1914). The fibers finally touch the prothallial cell. Then they fuse side by side to form a hollow wall enclosing the generative nucleus alone. This wall formation is likened to that described by Harper in free cell formation of the ascospores in mildews.

It seems to me that Hutchinson's figures as drawn are not entirely consistent with his own interpretation. A careful study of his own figures, taking into account the planes of the sections from which they were taken, seems to me to show that the cell division has really taken place in the regular manner by means of cell plate formation within an enlarging kinoplasmic fibrillar ring. The phragmoplast in these pollen divisions instead of extending outward in the same plane to form a flat circular plate between the two daughter nuclei, which would eventually reach the peripheral walls as is usual, in this case curves around the generative nucleus, toward the prothallial cell, and in doing so lays down a cup shaped cell plate. This is very clearly shown in his *fig. 44* (1915). Here the cell plate may be distinguished in vertical section as a faint line extending between the two daughter nuclei, curving down around the generative nucleus, and terminating in the kinoplasmic fibrillar mass. With the further movement of the kinoplasmic material toward the prothallial cell, the cell plate is extended until it meets the prothallial cell

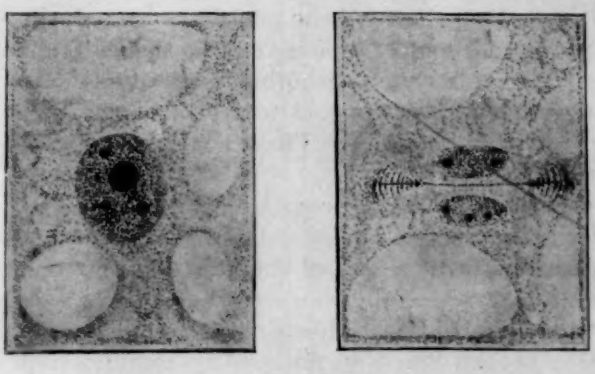
wall, thus cutting off by means of a cup shaped plate the generative nucleus from the tube nucleus. *Figs. 6*, and *7*, *plate 15*, show the kinoplasmic fibrillar ring at the stage when the peripheral fibers no longer are attached to the daughter nuclei, but are arising anew in the cytoplasm as the cell plate widens. Contrary to Hutchinson's statement that the cell plate is not formed in the usual manner, but only when the fibrillar mass has moved away from the tube nucleus and surrounded the generative nucleus alone, in my opinion both these figures show conclusively that the cell plate has already been laid down in the usual manner, at the usual time. In these sections, the cell plate appears simply as a very plainly discernable line (edge view) apparent through the kinoplasmic fibrillar ring whose fibers curve distinctly inward about its periphery, toward the nuclei.

The figures so far discussed it seems to me admit of the interpretation I have suggested. *Fig. 8*, *plate 15*, however, seems really inconsistent with any hitherto known method of cell division. *Figs. 4*, *18*, *19*, and *43* all show evidence of the thickening of the primary central spindle fibers which initiate the formation of the cell plate. *Figs. 23* and *45* show as distinctly as does *fig. 44*, previously explained, the kinoplasmic fibers still in process of formation to complete a cup shaped plate, which is evident in all these figures as a curved line (edge view) surrounding the generative nucleus.

Lawson's (**10**) description of a peculiar method of cell membrane formation in the multinucleate peripheral primary cells and central cytoplasmic region of the prothallium of *Cryptomeria japonica*, is referred to by Beer and Arber (**4**) as an example of the probable occurrence of phragmospheres such as they describe. Lawson states that cell plate formation here is by means of the lateral fusion of the fibers of a hollow spindle. However, it is quite clear, although all the stages in cell plate formation are not given, that the same misinterpretation is being made here as in Hutchinson's description of free cell formation in the pollen grains, by the fusion of fibers side by side to form an enclosing membrane. His *figs. 24*, *31*, and *32* suggest very strongly not the formation of a hollow sphere of fibers (the phragmosphere of Beer and Arber) but simply the presence of the usual ring of kinoplasmic fibers laying down the cell plate which will eventually separate the daughter nuclei. The

sections having been cut directly across the fibrillar ring and parallel to the cell plate, here present the fibrillar complex as a ring of granules, each granule being a cross section of a fiber.

Similar to this no doubt should be the explanation of Piech's (**13**) claim that free cell formation occurs in development of the cell boundary about the generative nucleus in the pollen grains of *Scirpus paluster*. He describes the formation of a free cell in the cytoplasm by the simultaneous formation of two enclosing membranes between the primary nucleus and the surrounding cytoplasm. Immediately after the formation of the two membranes a vacuolar region arises separating the two from each



FIGS. 1, 2. Cell division in cells somewhat older and larger than embryonic cells, with several vacuoles (Type 2).

other as shown in his *figs. 31* and *32*. Piech evidently has not found the stages of cell plate formation figured by Hutchinson (**9**).

Whether Strasburger's (**16**) well known figures of free cell formation in *Ephedra* are also to be interpreted as polar and oblique views of division by a cup shaped cell plate is in my opinion a possibility to be considered, though cup shaped cell plates are not known in connection with any other division in the embryo sacs. Certainly the embryo sac of *Ephedra* should be further studied.

Treub (**23**) recognized two types of cell plate formation, Strasburger (**17**) a third type, and Schürhoff (15) four so-called types of cell plate formation. Bailey (**1**) points out that the

differences in these various types are due merely to differences in the distribution of the elements of the cytoplasm in different tissue cells and the relative position from which the division figure is studied.

In my opinion it is worth while in the interest of clearness to recognize at least five distinct variants or conditions of cell content relations to cell plate formation. I am illustrating the essential stages in these variants by a series of text figures.

1. Cell division in small cells with relatively dense cytoplasm and no large vacuoles. This is the familiar case illustrated in the embryonic tissues of root tips, in pollen cells, etc. The growth of the cell plate in such cases involves only a simple widening out of the central spindle with the addition of relatively few new fibers to form ultimately a biconvex lens shaped phragmoplast. This would correspond to Schürhoff's first type. It is shown in many original drawings and text book illustrations. (Hof, *pl. 3, 4.*) (Timberlake, *pl. 8.*) I have not regarded it as necessary to give diagrams here.

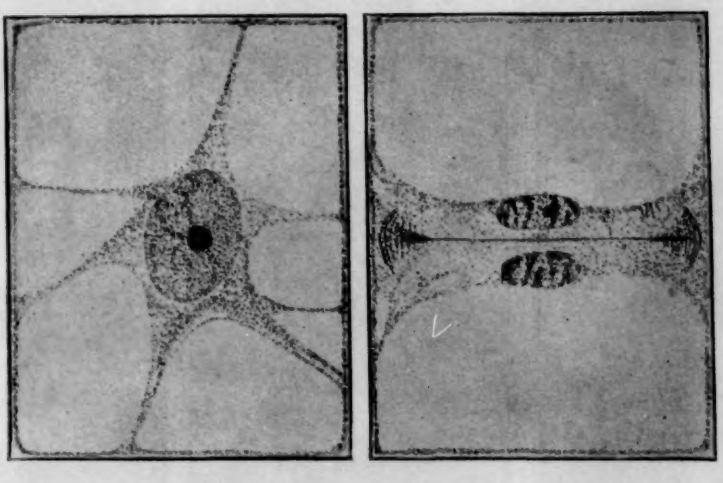
2. Cell division in somewhat larger cells containing several vacuoles. The nucleus lies in a dense mass of cytoplasm that occupies the central region of the cell. TEXT FIGS. 1 and 2 illustrate this type of cell, from a cross section of a very young leaf primordium below the growing tip of a tobacco stem. Such a division process differs in no essential features from that in embryonic cells.

3. Cell division in mature parenchymatous cells with a single central vacuole. Through this central vacuole extend cytoplasmic strands across the cell lumen connecting various regions of the primordial utricle. These tend frequently to be more or less centered on the nucleus and the streaming in them is sometimes said to be to and from the nucleus. Two cases of cell plate formation may be distinguished.

a. The nuclear division figure lies in the center of the cell, so that cell plate formation will go on progressively outward to the lateral walls of the cell, while the two daughter nuclei remain close to the cell plate in the original position occupied by the karyokinetic figure. TEXT FIGS. 3 and 4 are cells from the meristem of a tobacco plant stem growing tip, that illustrate this type. In polar view, the ring of kinoplasmic fibers would be visible about the two centrally placed nuclei, which typically

should appear to overlap. Such a ring of kinoplasm as it moves toward the periphery, and meets the walls of a many sided cell, may be divided up into one or more separate fibrillar arcs.

b. The nuclear division figure is eccentrically placed in the primordial utricle on one side of the cell, so that in cell plate formation one portion of the phragmoplast reaches the adjacent proximal lateral wall very soon, while the remaining arc of the fibrillar complex must develop peripherally across the entire cell to complete the cell division. If this arc should intercept the lateral walls at different times, it may as in (a), be broken



FIGS. 3, 4. Cell division in larger, more mature cells, containing a single large vacuole (Type 3a).

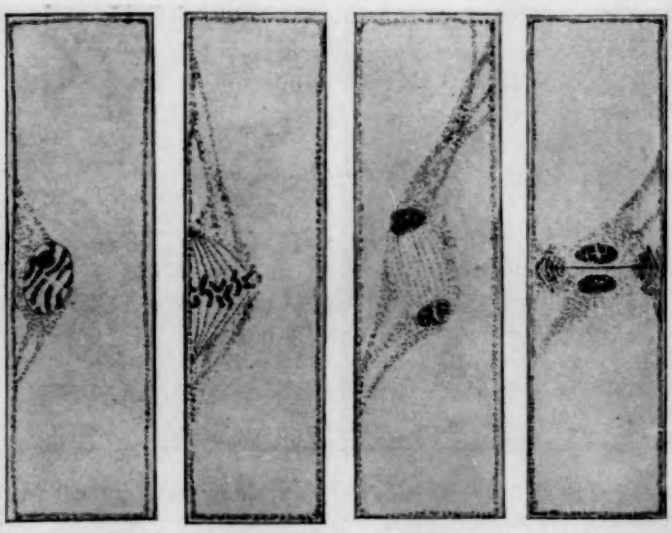
up into two or more separate arcs. The nuclei are usually located at a point equidistant from all parts of the kinoplasmic arc whether it is still entire or has been divided up into separate arcs by interception and fusion with the boundaries of the mother cell. If the kinoplasmic arc has a relatively small radius, the nuclei may accompany the fibrillar complex across the cell as Treub describes for his second type.

I include in this third group of division figures in large polygonal cells, several of the earlier recognized types. TEXT FIGS. 3 and 4, illustrate Treub's first type. PLATE 6 FIG. 4, illustrates Strasburger's third type. PLATE 6 FIG. 7, illustrates Schürhoff's

fourth type. PLATE 6 FIG. 10, illustrates Bailey's fifth type, as described for elongated cambial initials where the ring of kinoplasmic fibers is broken up into separate arcs.

4. Cell division in elongated cells containing a large central vacuole with practically no transverse cytoplasmic strands. During the resting condition, the nucleus lies in the primordial utricle. Cell division may take place longitudinally or transversely.

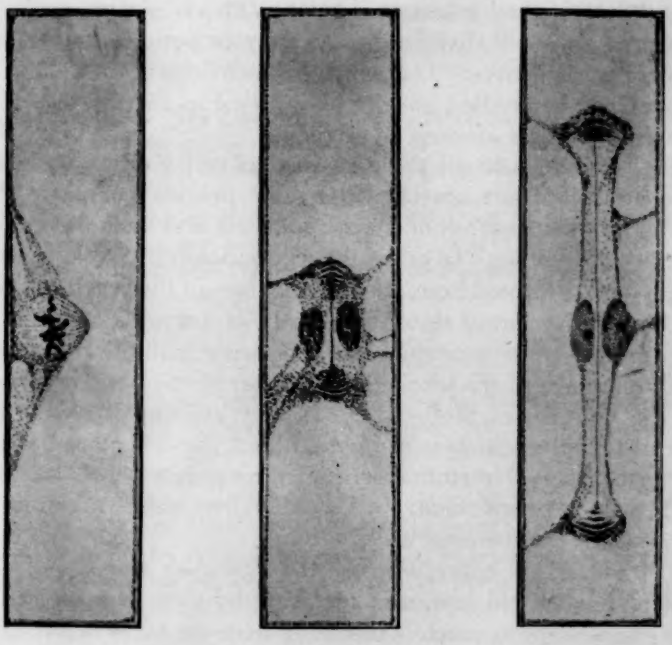
a. Transverse cell division in an elongated cell with one vacuole. The cytoplasm accumulates in the region of the nucleus



FIGS. 5–8. Stages in transverse division in an elongated vucuolate cell (Type 4a).

as it is about to divide so that the nucleus now lies somewhat away from the wall in the cell lumen, with cytoplasmic strands extending to the wall above and below it. The strands toward one end only move along the wall to the end of the cell, and cross it to the opposite lateral wall, so that the spindle figure now lies suspended in a diagonal massive strand or bridge of cytoplasm. Cell division now proceeds in the usual manner across the cell. TEXT FIGS. 5–8 illustrate the essential stages of such a division.

b. Longitudinal cell division in elongated cells with one large vacuole. TEXT FIGS. 9–11 show division stages in elongated vacuolated cells of the midrib of a very young tobacco leaf. The nucleus lies in the primordial utricle. The spindle and chromosomes are oriented for a longitudinal division even before the cytoplasmic strands in the manner described in 4a above, have drawn it away from the parietal layer and out into the



FIGS. 9–11. Stages in longitudinal divisions in an elongated vacuolate cell (Type 4b).

cell lumen. The cell plate is extended through the very long cell by two separate arcs of kinoplasmic fibers as in the elongated cambium initials described by Bailey. The entire fibrillar complex—cell plate, and peripheral kinoplasmic fibrillar arcs, is connected with the primordial utricle by strands of cytoplasm.

5. Cell division in such elongated elements as the cambial initials studied by Bailey, in which longitudinal division of the cell takes place by means of a very extended growth of the cell

plate through the great length of the cell. These are the most extreme cases of division by a cell plate so far observed, and their discovery by Bailey has brought the problems of cell division into a new light. As stated before, Timberlake's suggestion that the new fibers arise from the daughter nuclei seems hardly applicable here. None the less, as Bailey's figures show, the symmetrical position of the daughter nuclei with reference to the whole figure is a striking fact to be taken into account in any theory of the formation of the new fibers. As noted, I have observed such cell division figures only in petioles and midribs of very young leaves. The relative dimensions of the cells in the tissues I have studied are not so extreme as in the case of the cambium initials studied by Bailey.

It is obvious in all these cases that cell division by means of a cell plate is essentially the same process no matter how varied the distribution of the cytoplasmic and vacuolar content of the cell may be. In all we have a peripheral development of the cell plate formed from the original fibers of the central spindle.

The movement of the daughter nuclei toward each other and the forming plate, and the central position maintained by them with reference to the whole development of the fibrillar complex at the boundaries of the plate is very striking indeed. It is not until cell division is completed, and the cell plate has split to form two cell membranes, and a young cell wall has been laid down between them, that the daughter nuclei may migrate away from the forming wall.

Strasburger's conception of the fibers as threads of flow, which shorten, thicken, and fuse side by side to form the cell plate is perhaps as much in harmony with the facts as any of the various theories as to the fundamental nature of the processes here involved.

I gratefully acknowledge my indebtedness to Professor R. A. Harper for his many valuable suggestions in this study and in the preparation of this paper.

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Explanation of plate 6

The drawings were made with the aid of the Abbe camera lucida. A Zeiss microscope was used with a 1 12 inch oil immersion objective and a number 3 ocular. These figures were drawn above stage level at a magnification of 1000 diameters, reduced in reproduction to about 666 diameters.

FIG. 1. Lateral view of a division figure in a cell from the growing tip of a healthy tobacco plant. The biconvex lens shape stage of the spindle has been reached. The young cell plate within the last fibers of the central spindle which form the biconvex lens, appears in edge view as a thin dark line.

FIG. 2. A lateral view of a cell plate formation figure in a cell from a transverse section of a growing tip of a diseased tobacco plant. The fibrillar complex on one side has reached the wall of the mother cell and is partially fused with it. Several plastids lie in the cytoplasm along the cell plate, here appearing in edge view as a line. The daughter nuclei already lie close to the cell plate.

FIG. 3. A lateral view of cell plate formation in a cell from a longitudinal section of a leaf primordium of a healthy tobacco plant.

FIG. 4. Lateral view of a late stage in cell plate formation in a cell from a healthy leaf primordium. Here the nuclei have remained on one side of the cell, while the fibrillar complex has travelled a considerable distance across the cell.

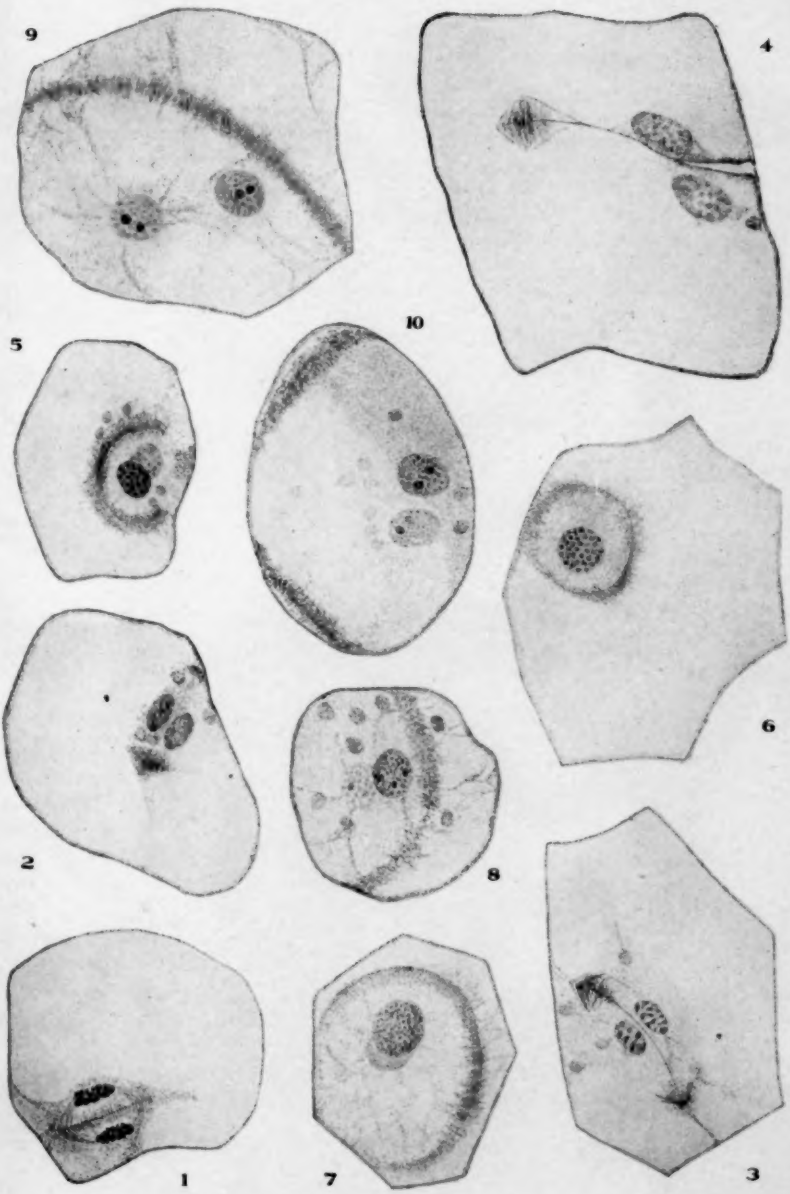
FIG. 5. A polar view of cell plate formation in a cell from a cross section of a healthy growing tip. The fibrillar kinoplasmic ring is almost entire. The cell plate which separates the two daughter nuclei within the ring, appears only as a faint granular haze. Several plastids lie in the cytoplasm about and within the ring.

FIG. 6. A polar view of a stage in cell plate formation from a cross section of a growing tip of a diseased plant. The cell is very large, and the section has not cut it favorably for showing the cytoplasmic strands about the fibrillar ring. One nucleus has been cut away, and the cell plate within the kinoplasmic ring is very clear as a round granular area which when seen in edge view on one side, appears as a thin line.

FIG. 7. Another polar view from the same section as in FIG. 6. This shows a later stage in cell plate formation. The fibrillar ring although nearly across the mother cell, has only merged with it in one corner of the cell. The two nuclei appear to overlap but lie one above the other with the delicate scarcely discernable cell plate between them. The cytoplasmic strands that lie along the surface of the cell plate are evident in this view.

FIG. 8. A somewhat tangential view of a late stage in cell plate formation in a cell of the growing tip of an old diseased plant cut in cross section. The fibrillar complex has intercepted the walls of the mother cell and now remains only as an arc of fibrillar material still moving across the cell. The cell plate which separates the two daughter nuclei is evident as a granular layer above which cytoplasmic strands and plastids lie. The lighter nucleus lies below the cell plate.

FIG. 9. A similar stage of cell plate formation to that shown in FIG. 8, in a very large centrally located meristematic cell in a cross section of a



GOLDSTEIN: CELL PLATE FORMATION

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healthy growing tip. The cell plate, which lies above the more lightly stained nucleus and ex ends from one wall of the mother cell to the concave side of the fibrillar complex at its periphery, is scarcely evident. This arc of kinoplasm when viewed in a longitudinal section would appear as a fibrillar mass at the free end of the cell plate as shown in FIG. 4.

FIG. 10. A cell from the cross section of the growing tip of a diseased plant. Here the fibrillar complex has intercepted the wall in such a way as to leave two separate kinoplasmic arcs. A portion of the cell plate which separates the two nuclei and which lies parallel to the section, is very clear on one side only as a very dark granular area. Where it sloped away from the plane of the section and therefore was not included in the section, it is only evident along the ring as a faint granular haze. The cell contains many plastids.

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Miscellaneous notes on plants of Southern California—IV*

PHILIP A. MUNZ† AND IVAN M. JOHNSTON‡

In this paper the following abbreviations are used in citing herbaria: G, Gray Herbarium; NY, New York Botanical Garden; P, Pomona College; S, Stanford University; UC, University of California; and US, U. S. National Herbarium.

Scirpus bernardinus sp. nov. Perennial, forming a very dense turf commonly several meters in diameter; plants densely caespitose, crowded, commonly with hard short stout vertical caudices (these covered with the dark persistent stem-bases) terminating dark-colored rootstocks ca. 1 mm. thick, producing no underground resting buds; stems several, gray-green, leafless, obscurely 3-angled, striate, wiry, 3–10 cm. long, characteristically spreading and recurving, more or less interlacing with those of adjacent plants; sheaths obliquely truncate, pale brown, 1–2.5 cm. long; spikelets solitary, terminal, not subtended by an involucral bract, ovate-oblong, laterally compressed, 3–6 mm. long, ca. 2 mm. thick, 4–6-flowered; scales reddish brown, margins hyaline, midrib thickened and dark, apex obtuse; lowest scale deltoid-ovate, ca. 3 mm. long and broad, hyaline margin broad; upper scales oblong, 4–5 mm. long, ca. 2 mm. wide; styles 3-cleft, ca. 6 mm. long, branches 2.5 mm. long; stamens 3; filaments ca. 1 mm. long; anthers basifixed, erect, ca. 1 mm. long; bristles 3 (or more ?), filiform, retrorsely barbed, equalling or surpassing the achene; achene oblong-obovate, coarsely beaked, ca. 1.8 mm. long, lenticular or obtusely trigonous, light brown, very lightly etched with longitudinal rows of more or less rectangular cells.

SAN BERNARDINO COUNTY: locally common in a wet meadow, South Fork of Santa Ana River, 8500 ft. alt., *Munz 6187* (TYPE, Pomona College Herb. no. 14332); South Fork of Santa Ana River, 8200 ft. alt., *Hall 7608* (G, UC).

Evidently a close relative of *S. pauciflorus* Lightf., under which species it has been placed by writers on the Southern Californian sedges. However, after a study of copious material of *S. pauciflorus*, from both North America and Europe, we have become convinced of the distinctness of the plant described

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† Pomona College, Claremont, California.

‡ Gray Herbarium, Harvard University.

above. It differs from its relative in its spreading recurved stems, densely caespitose turf-forming habit, and smaller, smoother, and less sharply angled achenes. The habit of growth is very peculiar, the plants forming a dense pure turf with the caudices so close and the stems so matted that a pick or collecting tool is driven into the mass with difficulty. It grows in the wet mountain meadows in the Canadian Zone of the San Bernardino Mountains where the frequent colonies are conspicuous because of their gray-green color, low dense growth and sharply defined limits. True *S. pauciflorus* is a very slender, erect, scarcely tufted plant with underground resting buds and very slender running rootstocks. In Southern California plants apparently referable to this species have been collected in the San Bernardino and San Jacinto mountains.

Alnus rhombifolia var. **bernardina** var. nov. Leaves averaging smaller than in the typical form, 3–5 cm. long, 1.5–3 cm. wide, densely soft pubescent, not resinous, frequently noticeably double-serrate; staminate aments short, 2–4 cm. long, 3–4 mm. thick; pistillate aments smaller, less woody and more slenderly pedunculate, 7–12 mm. long, 5–7 mm. thick.

SAN BERNARDINO COUNTY: Santa Ana River at junction of South Fork, 6300 ft. alt., *Munz & Johnston 8468* (TYPE, Pomona College Herb. no. 46794); South Fork of Santa Ana River, 6200 ft. alt., *Grinnell 303* (UC); Lost Creek, 7000 ft. alt., *Munz & Johnston 8615* (P); Foxesee Creek, 5500 ft. alt., *Munz & Johnston 8669* (P); Hathaway Creek, 6000 ft. alt., *Munz & Johnston 8671* (P).

A well marked but apparently local variation occurring in the pine belt of the San Bernardino Mountains in the upper portions of the Santa Ana River system between the altitudes of 5000 and 7000 ft. altitude. The most conspicuous character of the variety is the heavy pubescence on its leaves. At the lower edge of its range the variety grades off into the essentially glabrous and coarser plant of lower altitudes. It may eventually be found wise to include under the var. *bernardiha* certain forms of *Alnus* from the pine belt of the San Jacinto Mountains and other ranges of Southern California, but at present these are excluded, for although approaching the variety *bernardina* in pubescence, they do not have small leaves and aments.

In the present connection it may be mentioned that the

reports of the occurrence of *A. tenuifolia* Nutt. in Southern California and Lower California seem erroneous. These reports are apparently based upon Sargent's statement of range in the Silva of North America (**9**: 76. 1896). According to Sargent the species forms "great shrubby thickets six or seven thousand feet above the sea along the head-waters of the rivers of southern California which flow to the Pacific Ocean." Such collectors as Parish, Hall and Abrams have never reported thickets of any alder in the higher mountains of Southern California and have never recorded any specific occurrence of *A. tenuifolia* there. More recent collecting on our part in almost every portion of the region has likewise resulted negatively in this regard. Furthermore, search in all the important herbaria of the country including that of the Arnold Arboretum, has failed to yield any material of *A. tenuifolia* from south of the main Sierra Nevada of central California (Kern County?). Similarly no specimens have been found from Lower California. Examination of the cited reference, i. e. Zoe **4**: 216. 1893, upon which Sargent, *l. c.*, apparently based the inclusion of Lower California within the range of *A. tenuifolia*, shows that it was misread. The citation given refers to an *Alnus* reported by Katherine Brandegee from Bouldin Island in the lower San Joaquin Valley of California which was probably assumed to be from Lower California inasmuch as the preceding article in the journal was by T. S. Brandegee and concerning the flora of northern Lower California. In Mr. Brandegee's article no *Alnus* was mentioned.

Because of their well developed double serration the leaves of *A. rhombifolia* var. *bernardina* suggest those of *A. tenuifolia* rather than those of typical *A. rhombifolia*. The staminate aments of the variety, however, are clearly those of *A. rhombifolia*.

Malvastrum gabrielense sp. nov. An erectly branched shrub ca. 2 m. high; branches rather slender, virgate, with a dense close stellate-pubescence; leaves scattered, firm, shorter than the internodes, 2–4 cm. long, 1.5–2.5 cm. broad, obscurely 5-lobed, coarsely and irregularly serrate-dentate, stellate-pubescent, pale green, beneath somewhat lighter and prominently veined, apex broadly acute, base somewhat cordate; petiole densely stellate, 5–15 mm. long; stipules subulate, 8–9 mm. long, early deciduous; flowers in few-flowered glomerules in the upper axils; pedicels 0–3 mm. long; bractlets subulate, 7–12 mm. long, shorter

or longer than the calyx; calyx 10–12 mm. high, loosely stellate-pubescent, simply tomentose inside; calyx-lobes lance-ovate, ca. 8 mm. long, 3 mm. broad, strongly acuminate, enervous; petals pink, 16–18 mm. long, 8–9 mm. wide, strongly oblique-asymmetrical, sessile, rounded above; styles ca. 8 mm. long; style-lobes glabrous, slightly thickened at summit, 2–3 mm. long, ca. 10; stamens ca. 50, glabrous except at very base; connective prolonged as a subulate appendage which about equals the length of the anther-sacs; ovary stellate-pubescent; mature fruit unknown.

LOS ANGELES COUNTY: Arraster, north slope of San Gabriel Mountains, 3100 ft. alt., *F. W. Peirson 774* (TYPE, Pomona College Herb. no. 9927).

Malvastrum gabrielense appears to lack obvious relationships. From *M. orbiculatum*, with which it grows, it differs in its small more angular, thinner, less pubescent leaves, less densely pubescent stems and calyces, and more elongate calyces, bractlets and stipules. Though more leafy above, the inflorescence of the new species suggests the interrupted glomerate one of *M. viscidum*, a more southern species with hispid calyces.

Ammoselinum occidentale sp. nov. Annual scabridulous herb 10–15 cm. high, with numerous strict simple leafy branches; stems slightly angled, reddish tinged; leaves glabrous, ternately divided, 25–45 mm. long, ultimate segments linear, 5–8 mm. long, ca. 1 mm. wide; petiole of lower leaves becoming 25 mm. long, with an evident subsheathing hyaline-margin, that of the slightly reduced upper leaves much shorter; umbels compound, on naked terminal peduncles 15–50 mm. long that slightly surpass the leaves; involucre absent; involucels linear-lanceolate, few, 3–5 mm. long, ciliate-denticulate; rays unequal, ascending, several, 2–8 mm. long; pedicels very unequal, 1–4 mm. long, angled; petals white, broadly obovate, ca. 0.8 mm. long, obtuse; sepals undeveloped; fruit (submature) ovate-oblong, ca. 3 mm. long; stylopodium conical; carpels obscurely 5-angled, closely armed with unequal stout subulate hairs; oil-tubes in triplicate under the 4 dorsal and lateral furrows, those of the commissural face larger, more separated and 4 in number; seed compressed dorsally, face plane.

RIVERSIDE COUNTY: locally abundant in heavy soil of a dry basin under shrubs and in the open, "Hayfields," Chuckwalla Valley, Colorado Desert, 500 ft. alt., April 13, 1922, *Munz & Keck 4930* (TYPE, Pomona College Herb. no. 13255).

This species is a very evident relative of *A. giganteum* C. & R. of Arizona and Coahuila, from which it differs in its lower,

more compact habit, unbranched stems, smaller more compact umbels, pubescent (rather than conspicuously callous-toothed) smaller carpels, and twice as numerous commissural oil-tubes. Like its relative, the proposed species differs from the two other members of the genus, i. e. *A. Popei* T. & G. and *A. Butleri* (Engelm.) C. & R., in having the lateral and dorsal oil-tubes in threes rather than solitary. For the two western species which have triplicate oil-tubes we are proposing the section **Hesperoselinum.** The relationship and the characters of the 4 species now referred to the genus *Ammoselinum* may be appreciated by a study of the following natural key.

Dorsal and lateral oil-tubes solitary, one under each furrow; carpels smooth or inconspicuously roughened. §*Euammoselinum.*
- Umbels sessile in the axils; commissural face of carpel not corky-thickened; fruit 2 mm. long or less, broadly ovate, smooth or nearly so.....*A. Butleri.*
- Umbels terminal and evidently peduncled; commissural face of carpel with 2 strongly thickened corky ridges; fruit 3–4 mm. long, oblong-ovate, somewhat roughened.....*A. Popei.*

Dorsal and lateral oil-tubes in threes; carpel roughened or coarsely pubescent. §*Hesperoselinum.*
- Fruit covered with coarse subulate hairs; commissural oil-tubes 4; stems simple, 1–1.5 dm. tall.....*A. occidentale.*
- Fruit covered with blunt callous teeth; commissural oil-tubes 2; stems loosely branched, 2–3 dm. tall.....*A. giganteum.*

Penstemon Peirsoni sp. nov. A pallid glabrous decumbent plant ca. 3 dm. tall; branches basal, erect, simple, ca. 3 mm. thick, internodes 2–4.5 cm. long; leaves rather firm, glaucescent, concolored, nerveless, inconspicuously dentate; basal leaves oblanceolate, obtuse, basally attenuate, 4–7 cm. long, 7–10 mm. broad, with petioles about 1 cm. long; middle cauline leaves gradually reduced, lanceolate, acute, subamplexicaul, 1–5 cm. long; inflorescence rigid, few-flowered, 8–13 cm. long, 2.5–4 cm. thick, narrowly and inconspicuously bracteate; peduncles 5–10 cm. long, curved upward and vertical above; pedicels slender, glabrous, 3–15 mm. long, usually strict, subtended by acute herbaceous lanceolate bracts 2–3 mm. long; calyx puberulent; calyx-lobes imbricate, acute, 4–5 mm. long, lateral margins white-hyaline; corolla about 2.5 cm. long, entirely glabrous, purplish-lavender; tube ca. 5 mm. long and ca. 3.5 mm. thick; throat ca. 15 mm. long, 7–8 mm. thick, weakly inflated; upper lip 4 mm. long, ca. 7 mm. broad, erect (?), lobes 2, ca. 1.5 mm. long, obtusely deltoid; lower lip 5 mm. long, ca. 9 mm. broad, erect, lobes 3, ca. 3 mm. long, ovate; sterile filament yellow-

bearded near tip, ca. 19 mm. long, reaching to corolla-sinuses; fertile stamens glabrous, reaching to corolla-sinuses; anther-sacs glabrous, ca. 1.7 mm. long, oblong-ovoid, ultimately explanate, lines of dehiscence confluent and extending to the base of each sac; mature fruit unknown.

VENTURA COUNTY: single plant on dry slope, Seymour Creek, Mt. Pinos, 5900 ft. alt., June 10, 1923, *Munz 6999* (TYPE, Pomona College Herb. no. 31596).

Apparently most related to *P. fruticiformis* var. *incertus*, but differing in its broader serrulate leaves, narrower stricter thryse, and smaller, glabrous, less inflated and more colored corollas. In gross habit it much suggests *P. heterophyllus* but has broader glaucous denticulate leaves, broader and shorter sepals, smaller less inflated lavender corollas, bearded sterile filament and completely dehiscent divergent explanate unappendaged (not subulate ciliate) anther-sacs. In our recent paper (Bull. So. Calif. Acad. **23**: 34. 1924) the type of *P. Peirsoni* is mentioned as a possible hybrid between *P. heterophyllus* and *P. Palmeri* var. *Grinnellii*. However, since recent critical restudy of the plant has shown that it does not have the anther-sacs of *P. heterophyllus* as once supposed, and particularly since *P. heterophyllus* is not known from the Mt. Pinos region, it now seems that the suggested parentage is improbable if not impossible. In its bearded style and elongate glaucous foliage *P. Peirsoni* is very suggestive of *P. fruticiformis* and its variety. Going southwest-ward towards Mt. Pinos from the type locality of *P. fruticiformis* the plants of this relationship are represented by the var. *incertus* which has less inflated, less bearded, more colored corollas. Hence the still less inflated, comparatively deeply colored glabrous flowers of *P. Peirsoni* seem the natural culmination of the trend which partially characterizes the var. *incertus*. *Penstemon Peirsoni* has leaves which are denticulate and broader than those of the var. *incertus*, being in these respects more like typical *P. fruticiformis*.

It is a pleasure to associate with this striking plant the name of Mr. Frank Peirson, of Pasadena, whose persistent collecting in the wilder portions of the deserts and mountains is adding much to our knowledge of the flora of our region. Mr. Peirson was with the senior author when the type of the new species was collected.

CHRYSOPSIS BREWERI A. Gray, Proc. Am. Acad. **6**: 542.

1865. (*Chrysopsis Wrightii* A. Gray, Synop. Fl. N. Am. ed. 2. 1[2]: 446. 1886.)

An examination of the type of *C. Wrightii* and a comparison of it with the suite of 21 specimens which now represents *C. Breweri* in the Gray Herbarium, has proved the essential identity of these two species. The type and only known collection of *C. Wrightii* consists of two stems just coming into flower, only one head, in fact, having open florets. The material is quite similar in habit and technical characters to Sierran collections at the same stage of development.

Chrysopsis Wrightii was discovered by W. G. Wright in 1882 about the summit of San Gorgonio Peak, the highest summit of the San Bernardino Mountains, and has been vainly sought by botanists later visiting that area. The presence of this very rare and local species in the San Bernardino Mountains has been very puzzling since it has been the only one of the endemic species of the pine belt of that mountain-mass which has not been repeatedly recollected. On the other hand its apparent rarity is quite typical of an increasing list of boreal species of the Sierra Nevada that have a very local or rare occurrence in the San Bernardino Mountains. As a synonym of *C. Breweri* the distribution of *C. Wrightii* is quite analogous to that of such species as *Crepis nana* Rich., *Senecio occidentalis* (Gray) Greene, *Sibbaldia procumbens* L., *Salix orestera* Schneid., *Parnassia californica* Greene, etc., all of which are widely distributed in the Sierras of central California and known in Southern California only through single collections.

Taraxacum californicum sp. nov. Plant 5–20 cm. high, usually glabrous; root rather thick, simple, dark, glabrous; leaves ascending to widely spreading, light green, oblanceolate, 5–10(–13) cm. long, usually 1–2 (or rarely nearly 3) cm. broad, obtuse or acutish, characteristically subentire or sinuate-dentate but occasionally somewhat runcinate-incised, long attenuate at base, in age promptly and cleanly disarticulating from the collar; scape one to several, suberect to decumbent, at anthesis more or less equalling the foliage but finally elongating, glabrous even when young; heads stout, broadly cylindrical, 10–15 mm. long, 8–12 mm. thick, very abruptly contracted at base and hence truncate; tegules numerous, strictly erect, practically ecorniculate, light green or less commonly dark, usually somewhat pruinose, commonly with a narrow scarious margin; exterior tegules not half the length of the inner ones, ovate-

lanceolate, acute, 5–7 mm. long, appressed; inner tegules linear-lanceolate, 12–15 mm. long, 2–3 mm. wide; flowers numerous, suberect, yellow, at anthesis surpassing tegules by 2–3 mm.; achenes pale brown, ca. 3 mm. long, coarsely rugose, above narrowly tuberculate and abruptly attenuate (not with a well developed snout); beak slender, 7–9 mm. long; pappus white, ca. 5 mm. long.

SAN BERNARDINO COUNTY: meadows east of Bluff Lake, *Munz 5630* (P); Bear Valley, *W. M. Pierce 101* (TYPE, Pomona College Herb. no. 12629); Bear Valley, *Parish Bros. 1461* (G, S, US); Bear Valley, 6500 ft. alt., *Parish 4977* (NY, S, US); Bear Valley, *Parish 3131* (US); South Fork Meadows, Santa Ana River, 8200 ft. alt., *Hall 7512* (UC); Mare Flats, *Crawford 946* (P, UC); Cienega Seca Creek, *Munz 6305* (P).

This species, the only native *Taraxacum* known from west of the Great Basin, is common in wet soil in the pine belt of the San Bernardino Mountains where it occurs from 6000 to 8500 ft. altitude. In Southern Californian references it has passed mainly as *T. officinale* var. *lividum* Koch, e. g. Hall, Univ. Calif. Pub. Bot. **3**: 272. 1907. In the monograph of the genus by Handel-Mazzetti (Monog. 74. 1907) it was referred to *T. lapponicum* Kililm., and in Sherff's recent treatment of the North American species of *Taraxacum* (Bot. Gaz. **70**: 342. 1920.) it was included in *T. ceratophorum* DC. From these species, however, *T. californicum* is readily separated, not only by its remarkably isolated range, but by having stocky cylindrical heads which are truncate at the base, small achenes, non-spreading scarcely exserted florets, and erect appressed ecorniculate tegules.

Notes on Fabaceae—V

PER AXEL RYDBERG

XYLOPHACOS: III. MISSOURIENSES

This group is characterized by the straight pod, the two sutures being about equally curved, and the apex rather abruptly acute, not at all upturned; otherwise the plants are of the same habit as those of the preceding group.

Pod obcompressed, the upper suture only prominent; hairs acute at each end..... 22. *X. vespertinus*
Pod compressed, both sutures prominent.
Corolla nearly 2 cm. long, purple; calyx-lobes nearly half as long as the tube..... 23. *X. missouriensis*
Corolla about 15 mm. long, white or merely purple-tinged, with a purple keel; calyx-lobes about one fourth as long as the tube..... 24. *X. cymboides*

22. XYLOPHACOS VESPERTINUS (Sheldon) Rydberg. Jones (Astragalus 215. 1923.) reduced this to a variety of *Astragalus amphioxys*, which it resembles a good deal in general habit and pubescence, but the pod is totally different and approaches that of *X. missouriensis*. I think that *A. chamaelucae panguicensis* Jones is the same. Jones transferred the latter to a variety of *A. argophyllus*, then raised it to specific rank and lastly returned it back to a variety of *A. amphioxys*.

COLORADO: Grand Junction, *Eastwood*, in 1892; collector not given, in 1894; Evans, *Johnston 635;* Arboles, *Baker 417;* Naturita, *Payson 309;* Durango, *Eastwood 5293*.—NEW MEXICO: Colfax Co., *20142;* Sacramento Mountains, *Earle 551*, Aztec, *Baker 418;* San Andreas Mountains, *Wooton*, in 1913; Pecos, *Standley 5020;* Socorro, *Eggleston 16244;* Otero County, *Eggleston 14411; Wooton*, in 1897; San Antonio, *Wooton 3841;* Raton, *Standley 6266;* Union Co., 6240; Farmington, *7097;* Sandia Mountains, *Ellis 434;* Carrioso Mountains, *Matthews* in 1892; Greenville, *Eggleston 20096;* Romaldo, *2011*.

23. XYLOPHACOS MISSOURIENSIS (Nutt.) Rydberg. *Astragalus missouriensis* was described from material collected in Upper Louisiana, probably somewhere in South Dakota. It is characterized by the more or less black-hairy calyx and the

peculiar pod, which has both sutures prominent especially when ripe, when the pod splits along both sutures. It is common from Saskatchewan and Alberta to South Dakota, Oklahoma, and Colorado, east of the mountains. It has been reported from New Mexico and Texas, but I have seen no specimens. *Fendler 149*, *Edwards*, and *Earle 82* from Santa Fe (all in flowers only) seem to be *X. pephragmenus; Bro. Aneci 103* seems to be *X. cyaneus*, and *Standley 5020* and *Baker 418*, *X. vespertinus*.

IV. Pygmaei

This group resembles much the Cyanei, but the pericarp of the fruit is pulpy and in age becomes dry and spongious, the exocarp at last becoming papery and separating from the endocarp.

Leaflets 7–11, obovate, obtuse.
- Pod straight, elliptic in outline ..... 24. *X. cymboides*
- Pod somewhat arcuate, lance-ovoid in outline..... 25. *X. pygmaeus*

Leaflets 1–5, lanceolate, acute; pod arcuate..... 26. *X. musiniensis*

24. Xylophacos cymboides (M. E. Jones) Rydberg resembles closely *X. missouriensis* in habit, flowers, and fruit, but the flowers are smaller and paler and the fruit is less woody and the thinner exocarp separates in age from the endocarp somewhat as in *X. pygmaeus* and *X. musiniensis*.

Astragalus amphioxys cymellus M. E. Jones (Astragalus 215. 1923) is a synonym of this, at least as to a specimen in Jones' herbarium, marked "Part of Type," from San Raphael Swell, the type locality given in the original description. This specimen can not be distinguished from the other species cited below, all from the same county of Utah.

Utah: Huntington, Jones *5464 j;* Emory, *5445 f;* Spring Glen, *Jones*, in 1896; San Raphael Swell, *Jones*, in 1914.

25. Xylophacos pygmaeus (Nutt.) Rydberg. This species was first described as *Phaca pygmaea*. As there was already an *Astragalus pygmaeus*, Dr. Gray proposed the name *A. Chamaeluce* but placed it next to *A. tephrodes* and *A. aridus*. Sheldon followed Gray and added to the group *A. castanaeformis* and *A. Newberryi*. Jones redescribed it under the name *A. Cicadae*. After discovering that he had redescribed *Phaca pygmaea* or *Astragalus Chamaeluce*, he made his species a variety thereof

without pointing out any distinctive characters. In his Revision he adopted the name *Astragalus pygmaeus*, although at least two species had been described previously under that name.

COLORADO: De Begue, *Osterhout 4467*.—WYOMING: Fort Bridger, *A. Nelson 4605;* Green River, *Rydberg*, in 1895; Ham's Fork, *Nuttall*.—UTAH: Emory County, *Jones*.

26. XYLOPHACOS MUSINIENSIS (M. E. Jones) Rydberg. This resembles *X. medius* Rydb. in pubescence and in the form and pubescence of the leaflets, but the latter are seldom more than two pairs and the pod has the structure of that of *X. pygmaeus*. The type came from Ferron, Utah. Other specimens seen are from Spring Glen, Emery County, collected by Jones.

V. ERIOCARPI

This group combines the appressed silvery pubescence of the preceding group with the woolly pod of the next following:

Leaves elliptic or oblanceolate to obovate; calyx-teeth one-fourth to one-third as long as the tube.
- Leaflets 5–7, broadly oblanceolate to obovate, silvery white, pod densely villous
  - Leaflets mostly obovate, obtusish; peduncles much shorter than the leaves..... 27. *X. Newberryi*
  - Leaflets oblanceolate, mostly acute; peduncles about equalling the leaves..... 28. *X. medius*
- Leaflets 9–19, merely canescent, rarely more than 1 cm. long; pubescence of the pod comparatively sparse.
  - Leaflets 3–8 mm. long, elliptic to oval, obtuse..... 29. *X. marianus*
  - Leaflets 8–15 mm. long, lance-elliptic, acute..... 30. *X. eurekensis*

Leaves broadly obovate-cuneate, rounded, truncate or retuse at the apex; calyx-teeth half as long as the tube..... 31. *X. Watsonianus*

27. XYLOPHACOS NEWBERRYI (A. Gray) Rydberg. This was first collected by Newberry on the Ives Colorado Expedition, and really was the plant that Dr. Gray had in mind, when he changed *Phaca pygmaea* Nutt. to *Astragalus Chamaeluce* A. Gray. As Gray expressedly stated that he was obliged to change the name *P. pygmaea*, the latter must be regarded as the type of *A. Chamaeluce*. *X. pygmaeus* and *X. Newberryi* are very much alike in habit, and, mainly differing in the fruit, it was not surprising that Gray regarded Newberry's plant,

collected in flower only, as the same as that of Nuttall. *A. candelarius exiguus* Sheldon as to the Utah specimens is nothing but *X. Newberryi*.

Jones' variety *A. Newberryi castoreus* differs little from the type, the calyx-lobes being slightly blackish. His hybrids *A. Purshii* × *Newberryi* (as to the Nevada specimens named by Jones) and *A. Purshii Watsonianus* (Astragulus 216. 1923) belong also here, and do not differ from the var. *castoreus*. In his monograph, Jones does not cite any specimens of *A. Purshii* × *Newberryi* from Nevada, but in his herbarium, now at Pomona College, there are three specimens so labelled, two from Auburn and one from Centerville, and one of *A. Purshii* × *Watsonianus* also from Centreville of the same date. These are all the same but have nothing to do either with *X. Purshii* or *X. Watsonianus*.

WYOMING: Fort Bridger, *A. Nelson 4605*.—UTAH: Milford, *Jones*, in 1880; *Stokes*, in 1903; St. George, *Jones 5006*; Marysvale, *5338 l;* Panguish, *Palmer;* Dugway, *Jones*, in 1891; Glenwood, *Ward 225*.—ARIZONA: NEWBERRY (Ives Expedition); Peach Springs, *Jones, 68; Lemmon*.—NEW MEXICO: Aztec, *Baker 420*.—CALIFORNIA: Inyo County, *S. W. Austin 529*.—NEVADA: Palmetto Range, *Purpus 5868;* Centreville, *Jones*, in 1893 (labeled *Astragalus Purshii* × *Watsonianus);* Aurum and Centreville, *Jones*, in 1893 (labeled *A. Purshii* × *Newberryi*); Austin, *Hitchcock 767*.

28. **Xylophacos medius** Rydberg, sp. nov. (*Astragalus eriocarpus* M. E. Jones, Zoe **3**: 293. 1893. Not S. Wats. 1871. *Astragalus consectus* Sheldon, Minn. Bot. Stud. **1**: 143, in part, 1894. *Astragalus Newberryi* × *eurekensis* Jones, Astragalus 217. 1923.)

Subacaulescent perennial, with a cespitose leafy caudex; leaves 4–7 cm. long, ascending; stipules lanceolate, 3–5 mm. long; leaflets 5–9, oblanceolate or rhombic-oblanceolate, acute, 1–2.5 cm. long, 5–8 mm. wide, silky-canescent on both sides; peduncles 5–8 cm. long; racemes 3–6-flowered; bracts lanceolate, 5–6 mm. long; calyx strigose, somewhat nigrescent, the tube about 1 cm. long, the teeth 2–3 mm. long; corolla 2–2.5 cm. long, purple-tinged, the keel with a dark purple tip, otherwise as that of *X. Newberryi;* pod villous, the hairs becoming tawney in age, obliquely lance-ovoid in outline, 2 cm. long, rounded at the base, arcuate, 1 cm. broad and 5–7 mm. deep.

Type collected at Lake Point, Utah, May 29, 1880, *Jones 1743* (herb. N. Y. Bot. Gard.).

This species was first collected in Southern Utah (*Parry 44*) and named *A. eriocarpus* S. Wats. Sheldon included this specimen in his *A. consectus*. It was then collected at Dog Valley, Utah (*Jones 1690*) and named *A. Chamaeluce*. This number as represented in the Torrey herbarium is in early bloom, and the leaves not fully developed. Jones later changed the name to *A. cibarius* Sheld., which name belongs to Jones' own *A. arietinus*. From what can be judged from a later statement of Jones, (Contr. W. Bot. **8**: 12. 1898) it seems as if he intended to include this in his *A. eurekensis*. Later in the year Jones collected apparently the same species at Lake Point (*Jones 1743*), which he named *A. eriocarpus* S. Wats. Sheldon determined this number as *A. suturalis* Sheld., which is merely a substitute of name. At last Jones (Astragalus 217. 1923) based on this number his *A. Newberryi* × *eurekensis*. There is no evidence given by Jones why this should be regarded as a hybrid. I have seen no specimens either of *X. Newberryi* or of *X. eurekensis* from the Great Salt Lake valley. That the plant is somewhat intermediate between the two species is not proof enough that it is of hybrid origin. From *X. eurekensis* it differs in the more brightly colored corolla, the less numerous, larger and comparatively broader leaflets; from *X. Newberryi* in the larger acute leaflets and the longer peduncles; and from *X. Watsonianus* by the fewer, narrower, acute (not rounded to retuse) leaflets, the shorter flower, the shorter calyx-lobes and shorter and less curved pod.

UTAH: Lake Point, *Jones 1743;* Dog Valley, *1690;* southwestern Utah, *Parry 44.*

29. **Xylophacos marianus** Rydberg, sp. nov. Subacaulescent perennial, with a cespitose caudex; stems 1–3 dm. long; leaves 3–7 cm. long, with a slender rachis; stipules ovate or deltoid, 2–4 mm. long; leaflets 11–19, oval, obovate, or broadly elliptic, mostly obtuse, 3–8 mm. long, grayish-strigose; peduncles 2–4 cm. long; racemes 2–6-flowered; bracts lanceolate, 3 mm. long; calyx villous, the tube 8–10 mm. long, the teeth subulate, 3 mm. long; corolla about 2 cm., rarely 2.5 cm. long, apparently only purple-tinged; banner obovate, slightly arcuate; wings shorter, the blades oblong, with a broad auricle; keel-petals still shorter, the blade broadly lunate, rounded at the apex; pod lance-ovoid, 15–18 mm. long, 8 mm. broad and deep, moderately arcuate throughout, villous but not densely so.

Type collected at Marysvale, Utah, June 1, 1894, *Jones 5355* (herb. N. Y. Bot. Gard.).

The type was distributed as *Astragalus Purshii*, but the plant is evidently more closely related to *X. eurekensis*, from which it differs in the smaller, comparatively broader, obtuse leaflets, and the smaller less curved pod. Apparently the same plant, but stouter than the type, was collected in flower only near Utah Lake by Fremont and distributed as *Astragalus missouriensis*. Dr. Gray changed the determination to *A. Shortianus minor*, to which it is not closely related.

It is also *Astragalus Purslianus* × *Newberryi* Jones (Astragalus 216. 1923) mainly, but I do not think it is a hybrid of the two, having much smaller flowers than either. The only character in which it approaches *H. Newberryi* is the appressed pubescence, but at the same time this is shorter and coarser. The specimens from Dugway and Cedar Fort were included in Jones' so-called hybrid.

UTAH: Marysvale, *Jones 5355;* Cedar City *Jones 5200;* Fish Lake Cañon, *Garrett 2513;* Utah Lake, *Fremont 406*, in 1845; Dugway, *Jones*, in 1891; Cedar Fort, *Jones*, in 1896; Fish Lake Forest, *Eggleston 11108, 11139, 11109;* Ephraim, *Tidestrom 532, 104;* Homansville, *Jones* in 1891; Loa Pass, *5639 g;* Soldier Summit *5601 c;* Jugtown, *5405 c.*

30. XYLOPHACOS EUREKENSIS (M. E. Jones) Rydberg. This species resembles *X. argophyllus* a good deal in habit and leaf-form, but the pod is different, being silky villous, though not as densely so as in *X. Newberryi* or *X. medius*. In this respect it resembles more that of *X. glareosus*, from which it is most easily distinguished by the appressed pubescence of the leaves.

For many years Jones regarded this as *A. glareosus*. Upon discovering his mistake he substituted the name *A. eurekensis* Jones (Contr. W. Bot. **8**: 12. 1898). He did not cite any specimen, however, and hence no type locality is given. We might assume that it is Eureka, Utah, where he collected specimens in 1891. The sheet of this collection in the Gray Herbarium represents a depauperate form, but specimens from Cedar Fort, in 1896, show the other extreme of the species.

UTAH: Eureka, *Jones*, in 1891; Cedar Fort, *Jones*, in 1896; Ephraim, *Tidestrom 2083, 1000.*

31. XYLOPHACOS WATSONIANUS (Kuntze) Rydberg. This differs from its nearest relatives in the broad leaflets, rounded to retuse at the apex, the larger flowers, darker calyx, longer calyx-teeth and longer pod, strongly arcuate towards the tip. It was originally described as *A. eriocarpus* S. Wats.; there being an older *A. eriocarpus*, the name was changed to *Tragacantha Watsoniana* Kuntze and *Astragalus suturalis* Sheldon. Jones reduced it to a variety of *A. Newberryi* using first *eriocarpus* then *Watsonianus* as varietal names. Jones included in it *A. candelarius* Sheldon, but I think erroneously. He stated (Astragalus 217. 1923) that it is "common throughout the Great Basin from the base of Wasatch to the Sierras and southward to Owen's Valley and the southern flanks of the Mogollons of Arizona." Even if *A. candelarius* is included, this area is altogether too large. I know it only from the type collection from Coyote Mountains, Nevada (apparently West Humboldt Mountains). Watson also recorded it from the Trinity and East Humboldt Mountains. Stokes' specimens from Palisades may belong here also.

INDEX TO AMERICAN BOTANICAL LITERATURE

1911–1925

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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